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# Analysis of Impact of Cremation on Water Quality of River Ganga at Digha Ghat in Patna, Bihar, India

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**Abstract**

**Purpose:** Water related ecosystems face numerous threats, including pollution, climate change and overexploitation. The extent of surface water bodies, such as lakes, rivers and reservoirs, are rapidly changing worldwide. Traditional belief holds that being cremated at the bank of Ganga River and immersing ashes cleans the sins of those who die and carry them directly to salvation. Cremation remains when combine with river water, directly or indirectly impact human health and harms aquatic life. The present study was carried out at cremation ground on the river Ganga at three sampling sites near Digha Ghat in Patna district of Bihar, India. The objective of the study was to investigate water quality and suitability of water of Ganga River for aquatic life, irrigation and drinking.

**Methodology:** Total twelve physiochemical parameters *viz* temperature, TDS, pH, turbidity, electrical conductivity, total hardness, calcium hardness, magnesium hardness, DO, BOD, alkalinity, acidity, chloride, fluoride, phosphates, sulphates, sodium, potassium, iron were analysed by using standard methods described by APHA and the results were compared with water quality standards prescribed by Bureau of Indian standard (IS:10500).

**Findings:** The abundance of major ions trends indicating impacts of cremation activities on river water quality. Parameters, DO, BOD and phosphates were not recorded within permissible limit in water samples collected from cremation ground at Digha ghat. Higher values of turbidity at locations near cremation ghat may be attributed to addition of ashes bathing and other anthropogenic activities.

**Unique Contribution to Theory, Practice and Policy:** The study suggests that deterioration of water quality at cremation ghat of river Ganga needs regular monitoring and conservation measures.

**Keywords:** *Water Pollution, River Water Quality, Cremation Ghats, Water Conservation, Irrigation, Aquatic Life, Sustainable Development*

**JEL Codes of Classification:** *Q01, Q25, Q28, Q53*

## INTRODUCTION

Access to safe water, sanitation, and hygiene is the most basic human need for health and well-being. Billions of people will lack access to these basic services in 2030 unless progress quadruples (UN SDG 6 2012) however recent report raised concern over stagnation or decrease in access in urban areas (UN SDG Report 2023). River water has always been an indispensable need for living beings from the ancient period. There are various sources that lead to water pollution such as runoff water from agricultural land, urbanization anthropogenic activities which stem from industrial effluents, domestic activities, and agricultural activities such as the application of fertilizers, manures, pesticides, animal husbandry activities, irrigation practices, deforestation, and aquaculture. Rivers and streams are highly heterogeneous at spatial as well as temporal scales and several investigators have documented this heterogeneity focusing on the physico-chemical dynamics of rivers (Singh et.al. 2010). spatiotemporal variation in trace elements in Patuxent River of Maryland were examined (Riedel et.al.2000) while variations in parameters in the Nemunas river of Russia (Sileika et.al. 2006) and in Altamaha River ofGeorgia (Schaefer et.al. 2007) were analysed. Natural processes such as weathering of rocks, evapotranspiration, atmospheric deposition, climate change and natural disasters cause changes in the quality of river water and influence on river water quality in urban and rural areas (Anh et.al. 2023).

The river Ganga, also known as the Ganges, holds immense importance to the people living in Patna, Bihar. The Ganges is one of the most sacred and spiritual rivers of Bharat. It is the holiest river of Hinduism; we call it “Mother Ganga” because it is venerated as an “elixir”. The origin of The Ganges River is Gomukh in the mountains of Garhwal Himalaya (30º55N, 79º7E). The mainstream, called Bhagirathi originates at a height of 10,300 feet (3,140m) above sea level in the state of Uttarakhand. It is around 2, 525 km (1,569 miles) long in total. In Bihar, it covers around 445 km of length of a total of 2,525 km, and in Patna, it covers around 99 km long distance (Ganges River basins retrieved 2023). The Ganges is lifeline of tens of millions of people, and it is home to approximately140 species of fish, 90 species of amphibians. As of today, Ganga is threatened by severe pollution. All the more the Gangetic dolphin, a species endemic to the Ganga River basin, faces several threats including dam and barrage construction, water pollution, overfishing and motorised transport.

Ganga, in some stretches, particularly during lean seasons has become unfit even for bathing. The threat of global climate change, the effect of glacial melt on Ganga flow and the impacts of infrastructural projects in the upper reaches of the river raise issues that need a comprehensive response (NMCG). Growing population and urbanization have a direct impact on the water bodies as the number of settlements and encroachment takes place around the vicinity of water bodies, leading to numerous pollution ways as in point or non–point sources (Devananda 2017). In Hindu tradition, funeral pyres are lit at cremation centre located at Ghat to cremate the deceased. Ashes of the deceased remains are immersed and are carried along with the holy water of the River Ganga (NMCG). Cremation remains are mainly composed of dry calcium phosphates and minerals, like the salt of sodium and potassium, and sulphur, 1-4% of carbon remains as carbonate because most carbons are oxidized during pyres. Cremated remains when combined with water and pollute the river directly and indirectly impact human health and harms aquatic life.

Studies (Joshi et al 2009) based on the different seasons over a period of two years of Ganga River water in Haridwar, Uttarakhand, India were done to awaken people to minimize the contamination and maintain the quality and purity levels of Ganga. The water quality of River Ganga was analysed by several workers (Praveen et.al 2013, Pandey et.al. 2014, Kumar et.al.2016, Imam et.al.2021). Assessment water quality of River Ganga from Digha Ghat to Gai Ghat in Patna District, Bihar, India (Singh et.al.2017), selected water quality parameters of River Ganges at Patna, Bihar (Rai et.al.2011) and a comparative study of physico-chemical and bacteriological parameters of three different ritual bathing Ghats of Ganga River in India showed variation in values (Kamboj et.al.2016).

Inputs of cities, factories, agricultural land, and anthropogenic activities fluctuate various physico-chemical parameters and purification of river water before domestic consumption and strict legal action was suggested (Jaiswal 2017). Deviation in various parameters at different sites sampling of River Ganga were observed (Kesari et al 2021) and unethical practices along the banks of the river Ganga contribute to an alarming pollution level (Jhariya and Tiwari 2020). A clear data gave evidence of the contamination and deterioration of water quality in the Ganga River due to the discharge of untreated sewage water, and domestic wastewater from the Patna urban area (Alam et.al.2024)

Studies on impact of cremation centres on Gomti River, Lucknow, Uttar Pradesh (Maurya and Sharma 2016) and negative impact on environment with respect to air and water quality by cremation activities in Manikarnika Ghat, Varanasi, Uttar Pradesh (Khwairakpam et.al.2018) raised utmost concern. In view of the Emerging Centre of Pollution at Varanasi Ghats a need of lead role of educational institutions, professional bodies for cleaning Ganga were addressed (Basak et.al 2015).

Twelve districts of Bihar are located on the banks of the River Ganges. These twelve districts are Buxar, Bhojpur, Saran, Patna, Vaishali, Samastipur, Begusarai, Munger, Khagaria, Katihar, Bhagalpur and Lakhisarai. The length of the Ganges River in Bihar is 445 Km, and the total length of the Ganges River is 2525 Km and in Bihar, the length of the Ganga River is maximum in the Patna district (Bihar Basins Retrieved 2023). Ganga Ghats of Patna also serve the population in various ways such as fishing, cremation, boating, religious events, bathing, and rituals.Present study area selected has been the cremation ground at Digha Ghat. It is one of the most famous Ghats in Patna, Bihar and is located on the eastern bank of the Ganga River. The results section of the research paper presents the findings of the physicochemical analysis conducted on the Ganga River water samples collected from different sites along Digha cremation ground site.

Attempt is made to analyse the water quality at cremation sites. The main objective of this study is to present an overview of the religious and traditional beliefs and its harmful impact on the Ganga River. The study is significant in the sense that millions of people living in Patna and surroundings depend and survive on Ganga River.

## METHODOLOGY

The samples for the study were taken from different sites on 10$^{th}$ April 2024. Total 12 water samples were collected in the 500 ml sterile bottles. These samples were collected manually with hands wearing laboratory gloves from 1 foot beneath the surface water. Total nine samples were collected in the morning between 6:30 am to 7:15 am, three each from the stream at cremation ground (S1, S2, S3), middle stream (M1, M2, M3) and stream at opposite bank (P1, P2, P3) of the Digha cremation ground of river Ganga. Rest of three samples (S1E, S2E and S3E) were collected in the evening around 7:00 pm from the stream at the cremation ground.

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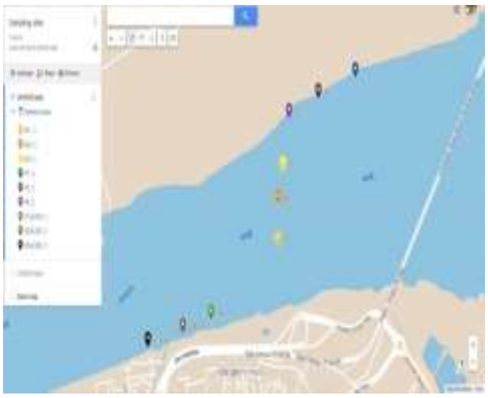
On spot measurements like temperature, pH, turbidity was performed for all the samples before taking them to the laboratory. All samples were preserved for further analysis. The physicochemical parameters were analysed as per as standard methods given by American Public Health Association (APHA 2017) and compared with water quality standard parameters (BIS:2012)

**Ganga River in Bihar, India** **Ganga River in Patna, Bihar, India**



**Study Sites on River Ganga at Cremation Ground, Digha Ghat, Patna, India**



**pH:** The relation of acid-base balance of water predominantly relies upon the affiliation between carbonates and bicarbonates and carbonic acid. The negative logarithm of the concentration of hydrogen is known as pH. The pH was determined using a digital pH meter (Systronics Model 361).

**TDS (Total Dissolved Solids):** TDS constitutes the ionic concentration of cations and anions of calcium, magnesium, potassium, sodium, carbonates, bicarbonates, chlorides, sulphates, iron, etc. and were calculated in mg/L. TDS was determined by using a conductivity-TDS meter (Systronics Model 307).

**EC (Electrical Conductivity):** The presence of acids, bases, and salts in water makes water a good electricity conductor. The potential to conduct an electrical current in water is measured in terms of Electrical Conductivity. EC is directly proportional to the concentration of acids, bases, and salts present in water. EC was measured as S/cm by using a conductivity-TDS meter (Systronics Model 361).

**Total Hardness (TH):** The concentration of polyvalence cations is defined as the concentration of calcium and magnesium ions (most common in fresh water) present in the solution; this refers to the total hardness of water. This was performed by taking a mixture of sample and buffer solution in 25 ml Borosil bottle (to maintain pH 10) followed by addition of a pinch of EBT (Eriochrome black-T) and titration with EDTA solution (0.01M). The results were calculated in terms of mg/L as $CaCO_3$.

**Calcium and Magnesium Hardness:** The presence of calcium ions dissolved in water is measured as calcium hardness. To a large extent leaching of rocks is the source of Ca and Mg in water. Ca hardness was determined by titrating 25 ml sample with EDTA solution (0.01M) using Murexide as an indicator. It was calculated in terms of mg/L.Magnesium hardness ($MgCO_3$ in Mg/L) is the difference between the total hardness and calcium hardness.

**Turbidity:** Turbidity is defined as the presence of suspended particles in water, which results in scattering of light. Turbidity of water is directly related to the scattering of light, i.e. it increases with the increase in the scattering of light. A Nephelometer (Systronics Model 132) was used to analyse the result, it was measured in terms of NTU.

**Chloride:** The concentration of chloride was determined by Mohr's method using $AgNO_3$ as a titrant. In 25 ml sample 4-5 drops of potassium chromate indicator were added and titrated with $AgNO_3$ till it turned brick red.

**Alkalinity:** The measuring capacity to neutralise acid or water buffering capacity is Alkalinity. Alkalinity was estimated by titrating 50 ml sample with 0.02N sulphuric acid followed by adding a few drops of phenolphthalein indicator (pH 8.3) to decolonize the sample. Indicator methyl orange was added to the same sample and titrated till it turned from yellow to pink. It is expressed in mg/L or ppm.

**Sodium ($Na^+$) andPotassium ($K^+$):** Sodium is highly soluble and found in most natural water sources. The salts of sodium yields softness in water. The determination of sodium was based on emission spectroscopy, which pertains to the emission of light when electrons come back after the electron's extraction from the ground state to a higher energy state. Photodetector measures the intensity of light.

Potassium can be used as an indicator for potential sources of contamination, attributed mainly to anthropogenic activities including agricultural land use and discharge of treated wastewater. Flame Photometer Systronics Model 128 at 489 nm was used for the measurement of sodium and potassium ions, respectively.

**Fluoride:** Fluoride-accommodating rocks, volcanic activities, forage, grasses, grains, and anthropogenic activities are the main sources of fluorides in water. A higher concentration of fluoride is commonly found in groundwater. Prolonged consumption of fluoride water causes chronic issues like dental fluorosis, skeletal fluorosis, etc. The ion-selective method was used for the determination of fluoride.

**Phosphate ($PO_4^{3-}$) and Sulphate ($SO_4^{2-}$):** Phosphates are mostly solely found in water. Sources of phosphate are agriculture wastewater, detritus, or deposition of crematory remains. The molybdenum blue phosphorous (MBP) method in congregation with a UV visible (1700) spectrophotometer at 830nm was used for analysis of phosphate ions. Sulphate was analysed at 420 nm wavelength by operating at UV-5100 Spectrophotometer (Systronics model (117). A standard sulphate solution and a blank solution were used in preparing the calibration curve.

**Acidity:** Estimation of acidity was conducted by titrating 50 ml sample with standard NaOH solution followed by adding phenolphthalein indicator and methyl orange indicator simultaneously till faint pink colour appeared.

**Dissolved Oxygen (DO):** Dissolved oxygen is one of the significant water quality parameters which also ensures its physical, chemical, and biological activities. 300 ml Borosil BOD bottles were used for sampling which were fixed tightly after collection and immediately brought to the laboratory. Winkler's method was used to examine the DO (mg/L) of the samples as per standard protocol of APHA.

**Biological Oxygen Demand (BOD):** To determine the demand for oxygen needed to digest biological wastes in water BOD was analysed. Samples were collected in 300ml Borosil BOD bottles and brought immediately to the laboratory. BOD (mg/L) of samples were analysed by Winkler's method as per APHA standards.

**Iron:** Iron is a heavy metal that is generally effective for health when it is at a higher concentration in water. It is the fourth most abundant element to be found in the earth's crust. The Spectrophotometer, Systronics model 129 was used to determine iron in the water samples.

## RESULTS AND DISCUSSION

Physiochemical parameters observed are incorporated in Table-1 and represented in Graphs 1to 12.

**Temperature:** The average temperature of water samples in the study area was in the range of 25ºC to 28ºC (Graph-1). The temperature in this study was found within prescribed permissible limit (BIS 2012)

**pH:** The pH of water in rivers is influenced by various biological, physical and geochemical processes such as photosynthesis, respiration of plants, $CO_2$ pressure equilibrium with the atmosphere, degradation of organic matter, geological and mineral background, and pollution. The maintenance of optimum pH in river water is also required for the sustenance of aquatic life (Matta et.al.2017), In present study maximum pH value was observed for the samples collected from streams on opposite bank of cremation ground ranges from 8.4 to 7.6, while the samples from mid stream of river show pH range from 7.9 to 8.0 (Graph-2). Higher pH in the samples collected from riverbank than in the samples of mid stream may be related with release of ashes, bathing, use of soaps, detergents and offerings of flowers and incense.

**Table 1**

| Parameters | IS 10500: 2012 Acceptable limit | IS 10500: 2012 Permissible limit | Samples | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Site 1: Near cremation ground (Morning) | | | Site 1: Near cremation ground (Evening) | | | Site 2: Opposite bank of cremation ground | | | Site 1: Midstream | | |
| | | | S1 | S2 | S3 | S1E | S2E | S3E | P1 | P2 | P3 | M1 | M2 | M3 |
| | | | 25°39'06.1"N 85°04'53.3"E | 25°39'06.2"N 85°04'53.7"E | 25°39'05.6" N 85°04'51.8"E | 25°39'06.1"N 85°04'53.3"E | 25°39'06.2"N 85°04'53.7"E | 25°39'05.6" N 85°04'51.8"E | 25°39'22.7"N 85°04'56.1"E | 25°39'22.8"N 85°04'58.3"E | 25°39'20.0"N 85°04'47.6"E | 25°39'13.2"N 85°04'54.7"E | 25°39'15.5"N 85°04'55.4"E | 25°39'17.8"N 85°04'53.5"E |
| **pH** | **6.5 - 8.5** | **NR*** | 8.20 | 7.90 | 8.1 | 7.9 | 8.05 | 8.05 | 7.7 | 7.6 | 8.4 | 7.9 | 8 | 8 |
| **Temperature ($^0C$)** | **NR*** | **NR*** | 26 | 26 | 26 | 28 | 28 | 28 | 26 | 26 | 26 | 25 | 25 | 25 |
| **Turbidity (NTU)** | **1** | **5** | 15.2 | 18.9 | 20.3 | 15.7 | 19.2 | 20.8 | 12.4 | 11.8 | 11.5 | 9.7 | 9.4 | 9.4 |
| **Total dissolved solids (mg/L)** | **500** | **2000** | 256 | 254 | 234 | 252 | 254 | 268 | 212 | 250 | 248 | 212 | 214 | 246 |
| **Conductivity (µS/cm)** | **NR*** | **NR*** | 378 | 366 | 342 | 370 | 376 | 392 | 314 | 364 | 366 | 314 | 320 | 362 |
| **Total Hardness (mg/L)** | **200** | **600** | 96 | 102 | 78 | 90 | 84 | 80 | 78 | 80 | 78 | 74 | 76 | 76 |
| **Calcium Hardness(mg/L)** | **75** | **200** | 16 | 33 | 10 | 19 | 40 | 14 | 16 | 13 | 11 | 18 | 18 | 13 |
| **Magnesium Hardness(mg/L)** | **30** | **100** | 37 | 19 | 32 | 36 | 16 | 30 | 28 | 31 | 31 | 25 | 26 | 29 |
| **$Mg^{2+}$/ $Ca^{2+}$** | | | 2.3:1 | 1:1.5 | 3:1 | 2:1 | 1:2.5 | 2:1 | 1.75:1 | 2.4:1 | 3:1 | 1.5:1 | 1.4:1 | 2.2:1 |
| **Alkalinity(mg/L)** | **200** | **600** | 176 | 186 | 168 | 170 | 182 | 172 | 198 | 214 | 206 | 198 | 170 | 176 |
| **Acidity (mg/L)** | **NR*** | **NR*** | 112 | 106 | 110 | 106 | 94 | 84 | 106 | 58 | 76 | 76 | 70 | 64 |
| **Chloride(mg/L)** | **250** | **1000** | 53.05 | 54 | 47 | 52 | 51 | 52 | 49 | 54 | 47 | 53 | 52 | 57 |
| **Fluoride (mg/L)** | **1** | **1.5** | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| **Sodium (mg/L)** | **NR*** | **NR*** | 48.08 | 53.25 | 46.56 | 52.54 | 48.86 | 49.04 | 44.7 | 44.1 | 43.78 | 44.21 | 26.85 | 43.32 |
| **Potassium(mg/L)** | **NR*** | **NR*** | 6.21 | 8.61 | 5.63 | 7.25 | 6.12 | 5.97 | 5.59 | 5.55 | 5.78 | 5.33 | 5.36 | 5.39 |
| **Iron (mg/L)** | **0.3** | **NR*** | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL |
| **Phosphate(mg/L)** | **NR*** | **NR*** | 1.35 | 2.01 | 0.5 | 2.3 | 1.2 | 0.3 | 0.4 | 0.4 | 0.3 | 0.1 | 0.1 | 0.1 |
| **Sulphate (mg/L)** | **200** | **400** | 355 | 358.5 | 350.99 | 360.2 | 366.5 | 355.7 | 220.51 | 222.6 | 216.0 | 150.6 | 144.2 | 145.1 |
| **DO (mg/L)** | **NR*** | **3** | 1.8 | 1.4 | 2 | 1.2 | 0.8 | 2 | 4.4 | 4.8 | 4.8 | 7.92 | 8.53 | 8.21 |
| **BOD (mg/L)** | **NR*** | **30** | 22.45 | 23.8 | 19.3 | 22.8 | 25 | 19.8 | 6.4 | 5.82 | 5.7 | 5.95 | 5.4 | 5.43 |

**NR* = No Relaxation**

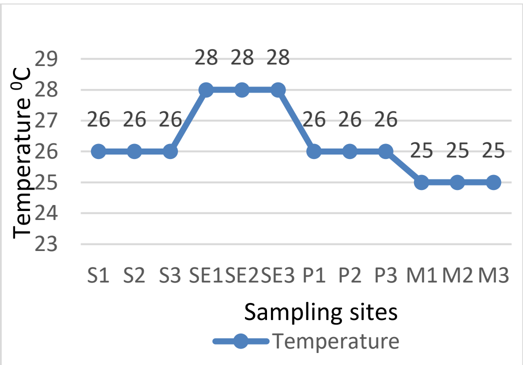
The pH values in the study were found within the acceptable limit as mentioned in (BIS 2012) guidelines for drinking water quality parameters.

**Turbidity:** Among the water quality parameters of river water, suspended solids are the easiest to observe intuitively and have quite common problems. The increase of suspended solids is often artificially regarded as one of the indicators of river water eutrophication (Sebastia et.al.2019). Therefore, the monitoring of water turbidity is of great significance to the management of the rivers. The observed values of turbidity were exceeding (between 9.4 to 20.8 NTU) as per the guidelines of Indian standard (BIS:10500) in all of the water sample analysed (Graph-3). Turbidity occurs due to the presence of soil, organic and inorganic matter plankton and other microscopic organisms. Higher values of turbidity at locations near cremation ghat may be attributed to addition of sewage and suspension of ashes from cremation ground.

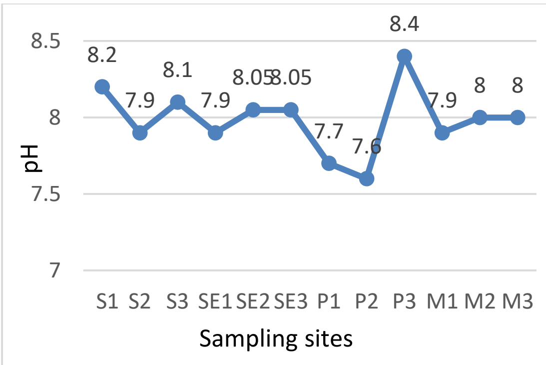
**TDS:** A higher TDS causes gastrointestinal irritation to human beings but prolonged water intake with higherTDS can cause kidney stones and heart disease. The presence of high value of TDS may be due to the influence of anthropogenic sources such as domestic sewage, and solid waste dumping. In the present study the values of TDS in all samples are within the permissible limit BIS. A correlation between the values of EC and TDS has been observed (Graph-4).The relation between turbidity and the Total Dissolved Solids (TDS) was measured. It is observed that there is increase in turbidity however TDS values are within the permissible range. It may be due to increased flow rate of water which causes decrease in TDS and increase in turbidity.

**Electrical Conductivity:** The salt concentration is usually measured by determining the Electrical Conductivity of water. Excess salt increases the osmotic pressure of the soil solutions which can result in physiological drought conditions. In the present study, maximum electrical conductivity was observed in sample S3E, collected from the side of cremation ground in the evening (392 µS/cm) and the minimum in P1 at opposite bank of cremation ground and in M1 at mid stream (314 µS/cm) (Graph-5). In rivers, normal conductivity levels come from the surrounding geology, clay soils contribute to conductivity. Any human activity that adds inorganic, charged chemicals to a river alter the electrical conductivity. Higher range of EC observed in the samples collected from the stream at the bank of cremation ground of Ganga River may be due to the dumping of ash in the river water which adds a huge amount of carbon compounds admixed with phosphate of component that comprises bone enamel and other hard part of human body.

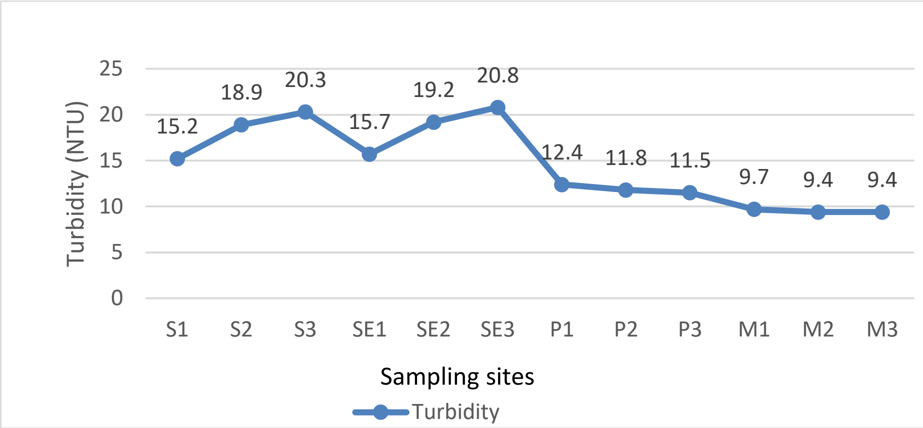
**Graph-1**



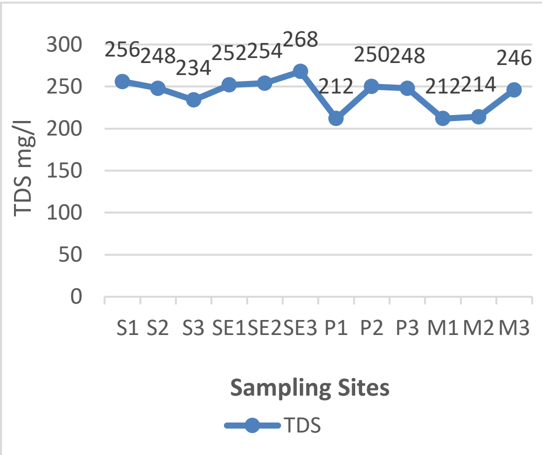

**Graph-2**



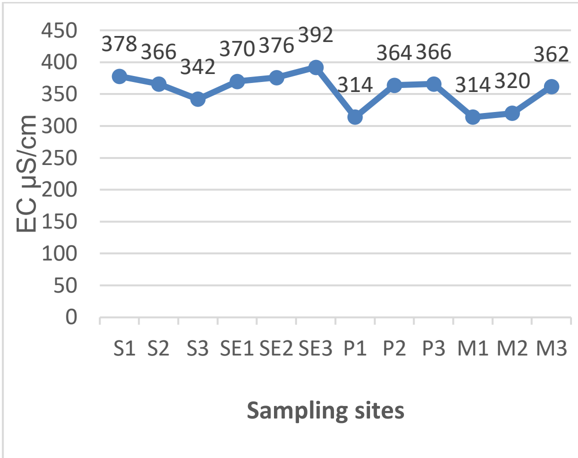
**Graph-3**




**Graph: 4**




**Graph: 5**




**Alkalinity and Acidity:** Alkalinity is primarily a way of measuring the acid-neutralizing capacity of water. Alkalinity in all the water samples of the river Ganga was found well within the desirable limit (200 mg/L) as per the specifications of BIS, 2012 drinking water. Maximum value of alkalinity, 214 mg/L was observed in sample P2 from opposite bank of cremation ground and minimum 168mg/L in sample S3 collected from the side of cremation ground. Measuring alkalinity is important to determining a river's ability to neutralize acidic pollution (as measured by pH). It is one of the best measures of the sensitivity of the river to acid inputs. Alkalinity comes from rocks and soils, salts, certain plant activities, and certain wastewater discharges. However maximum acidity (112 mg/L) was observed in sample S1 and minimum in the water sample P2 (opposite bank from cremation ground) 58 mg/L (Graph-6).

**Total Hardness:** Hardness is an essential parameter for drinking water from both aesthetic and quality aspects. Maximum Hardness was found in sample S2 collected from the side of cremation ground (102 mg/L) and minimum in the sample M1 collected from mid stream (74 mg/L). Total hardness in the range of 0-17 mg/L is marked as soft; 17-60 mg/L as slightly hard; 60-120 mg/L as moderately hard; 120-180 mg/L as hard and more than 180 mg/L as very hard. Hence, the hardness range falls in between 74 mg/L to 102 mg/L which shows that water is

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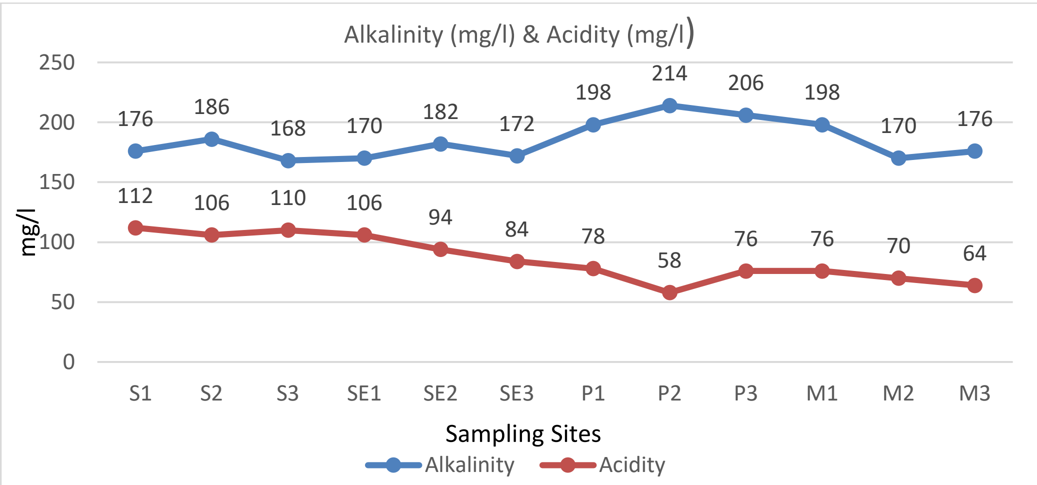
moderately hard (Graph-7). All the results fall within the range of permissible limit of BIS guidelines.

**$Ca^{+2}$ and $Mg^{+2}$ Ions Concentration:** Magnesium and calcium, which occur naturally in water bodies, are among the most highly available alkali metals in the environment. Magnesium salts are found naturally and in high concentration in surface and ground water, and the only other elements that occur in greater abundance are sodium and calcium cations. Magnesium and calcium concentrations in ground and surface waters increase as those elements are washed out from bedrock (Potasznik and Syzmczyk 2015).

In this study, magnesium content varied from 16 mg/L to 37 mg/L in Ganga River water. Maximum concentration of Mg ion was observed in stream at the crimination ground than in stream at opposite side and mid stream, while the calcium content varied from 11mg/L to 40 mg/L where maximum concentration was again in samples collected from stream at cremation ground followed by mid stream and opposite side. Concentration of both ions is within the permissible limits prescribed by standards. Magnesium levels were significantly higher than calcium levels in all the water samples collected from Ganga River, which may be due to disposal of flowers and leaves in river water during cremation of human dead bodies and magnesium is a component of chlorophyll.

**$Ca^{2+}$ and $Mg^{2+}$ Ratio:** The ratio of calcium and magnesium in water is also a crucial factor to cause several hard water related health problems. It was recommended that the Mg to Ca total intake ratio should be 1:2 as required for the best Mg absorption. Magnesium and calcium ratio was calculated and from the finding (Table-1& Graph-7), it is evident that this ratio is maintained only in samples S2 and S2E while in other samples, Mg to Ca ratio range between 3:1 to 1:1. An increase in Mg: Ca ratio has been observed which is associated with increasing risk for gastric cancer (Gangwar et.al.2024).

**Graph: 6**



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Vol.7, Issue 3, No.4. pp 40 - 56, 2024

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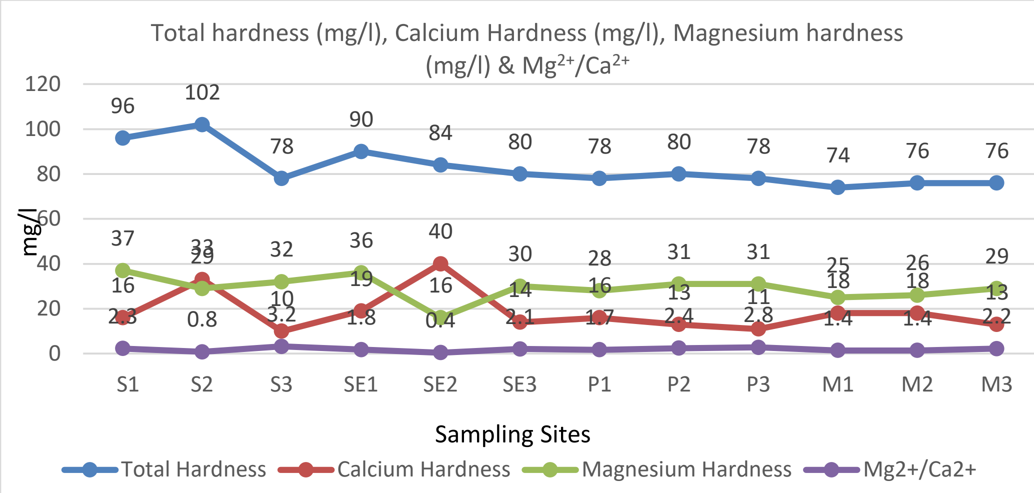
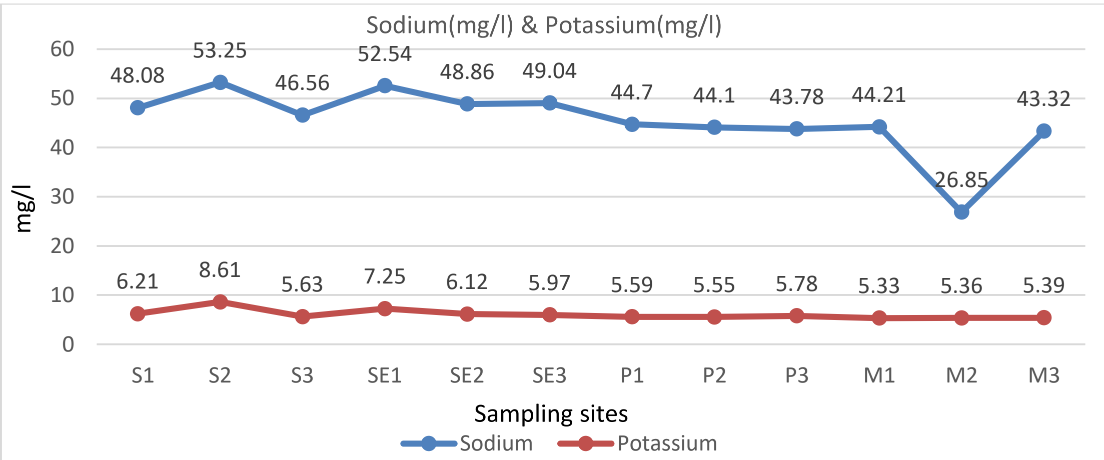
**Graph: 7**




**Sodium and Potassium Ions:** No guidelines have been established for Na and K. The sodium ion is ubiquitous in water. Most water supplies contain less than 20 mg of sodium per liter. The water-treatment chemicals, such as sodium fluoride, sodium bicarbonate and sodium hypochlorite, can together result in sodium levels as high as 30 mg/L.Domestic water softeners can give levels of over 300 mg/L. Proper quantity of sodium in human body prevents many fatal diseases like kidney damages, hypertension, headache etc.Concentration of Na in river water samples was found between 53.25 mg/L to 26.85 mg/L (Graph-8).

Potassium contents in the river water ranged from 5.33 mg $L^{-1}$ to 7.25 mg $L^{-1}$ (Table-1). K concentrations in sampling points under anthropogenic influence, i.e. sewage treatment plants, exceeded the level.The highest values of K, found in sample S2 from bank of cremation ground (8.61 mg/L) and lowest in M1 (5.33 mg/L).High concentrations of K and N in surface and groundwater causes not only environmental but also health problems in people with kidney disease, heart disease, coronary artery disease and diabetes.

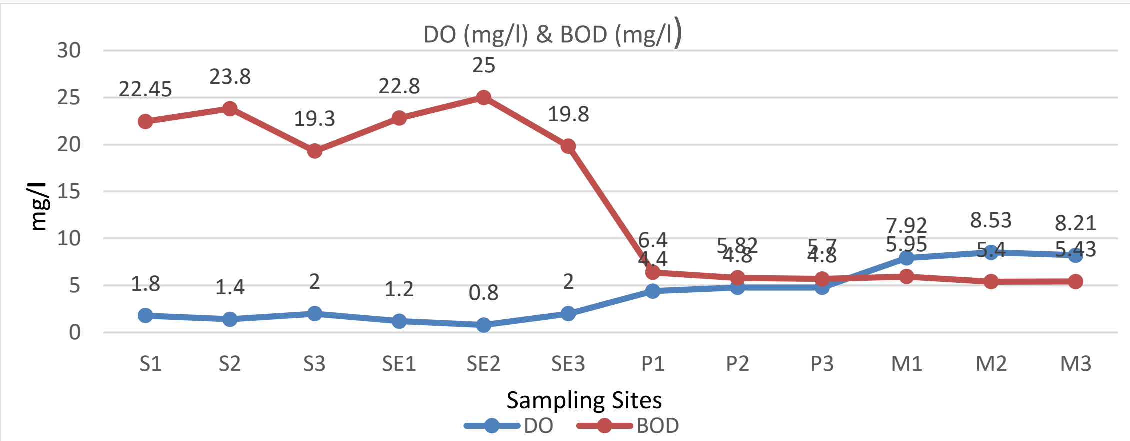
**Graph: 8**




**Dissolved Oxygen:** DO concentration in a river regulates significant processes for the sustenance of aquatic life. It is evident (Graph-9) that value of D.O. is increasing by moving from left to right (from riverbanks to mid stream). The results clearly indicate that excess accumulation of bioorganic matter and microbes, mass bathing at both side of the banks caused significant reductions in the values of DO (Srivastava et.al.1996). The lowest DO (0.8 to 2.0 mg/L) was observed in water samples collected from the side of cremation ground while in samples collected from the mid stream it ranges from 8.21 to 7.92 mg/L. The results indicate that cremation activities at Ghat, pollute water quickly and have led to oxygen starvation.

**Biochemical Oxygen Demand:** In river water, BOD shows the biodegradable fraction of the organic load. In the present study, the BOD of the sample S2E collected from bank of cremation ground in evening was found very high of 25 mg/L and the minimum value of BOD was observed in the sample M2 of mid stream (5.4 mg/L). Values of BOD observed in all samples are more than desirable limit (<2.0mg/L). Highest BOD in the water samples of Ganga River collected in evening hours, suggests accumulation of excess microbes due to release of ashes, bathing, use of soaps, detergents and offerings of flowers and incense during daytime which decreases progressively at the downstream side, mid stream and opposite side of the river (Srivastava et.al.1996).

**Graph: 9**



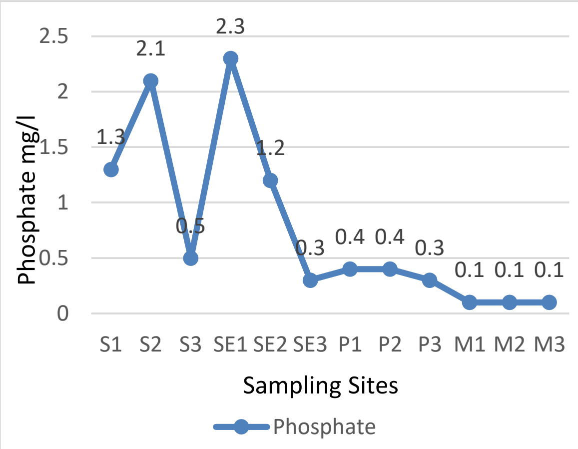

**Phosphates ($PO_4^{3-}$):** In the present study Phosphate concentration varies from 0.1to 2.3 mg/L. The maximum value of Phosphate was found at side of cremation ground in evening SE1 (2.3 mg/L) and the minimum value in midstream water sample (0.1mg/L). Observed values of phosphate in water samples at the stream of cremation ground are much higher than at opposite side stream and middle stream. It is well represented in Graph-10, where decline in the values is observed, while moving from left to right. Banks of river have undergone remarkable economic expansion since the industrial revolution. Large quantities of phosphorus have been transported to the banks as a result of industrial emissions, run-off of chemical fertilizers, cremation activities, animal manure from farmland, seriously polluting some offshore river. The results suggest that the cremation activities at Digha Ghat of River Ganga have contributed to increased values of phosphate.

***Sulphate ion Concentration:*** Higher concentration of sulphate in samples collected from the bank of cremation ground than to the samples collected from opposite bank and mid stream is because cremation remains, which are immersed in water also contain sulphur (Graph-11).

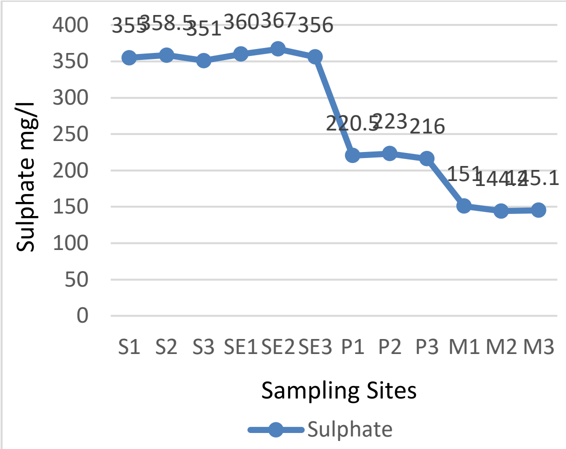
International Journal of Environmental Sciences
ISSN 2519-5549 (online)
Vol.7, Issue 3, No.4. pp 40 - 56, 2024



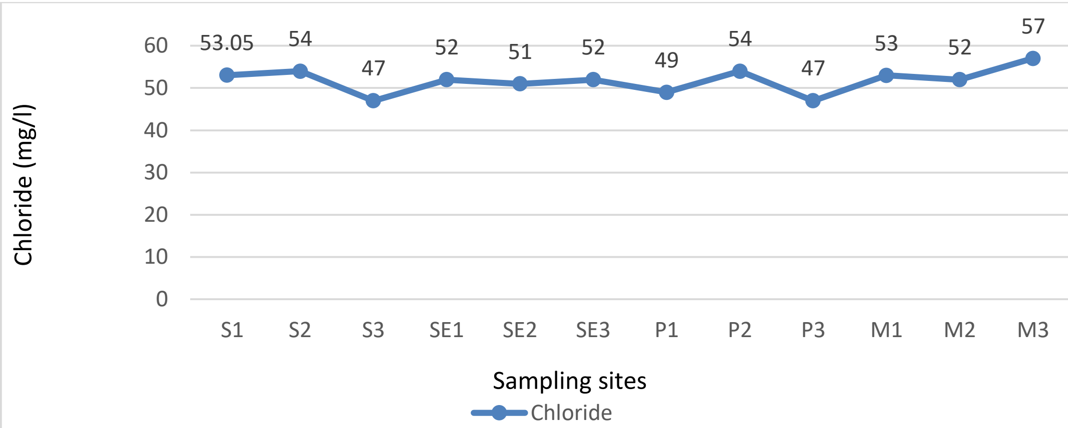
**Graph: 10**




**Graph: 11**




**Graph-12**




**Chloride ion Concentration:** Chloride sources in surface water may include rocks containing chlorides, agricultural runoff, wastewater from industries, oil well wastes, industrial and waste water effluents and road salting. Chloride concentration in all the samples was between 47 mg/L to 57 mg/L (Graph-12). All values are within the permissible limit prescribed by BIS.

**Fluoride:** Some studies have found that groundwater in isolated areas of the Ganges basin in Bihar contains fluoride levels that exceed the BIS limit for human consumption and research on mitigation measures for fluorosis patients have been reported from CFR laboratory (Singh el.al.2022,2023). Fluoride is an important parameter for establishing quality of drinking water. It was found to be fairly lower than the standard limit of 1.0 mg/L.

## CONCLUSION AND RECOMMENDATIONS

This study aims to assess the physicochemical parameters of Ganga River water around Digha Ghat cremation grounds situated in Patna district of Bihar, India and their potential impact on environmental health.The concentration of various physico-chemical parameters pH, EC, TDS, hardness, D.O., B.O.D., alkalinity, phosphates, sulphites, sodium, and potassium were recorded and among these parameters, D.O., B.O.D., and phosphates were not recorded within the permissible limit in the water samples collected from cremation ground at Digha Ghat. Our findings reveal a significant decline in water quality, particularly at Cremation Ghat, by analysing key parameters such as biochemical oxygen demand (BOD), dissolved oxygen (DO), pH, phosphates and sulphates in collected water samples. Cremation remains are mainly composed of dry calcium phosphates and minerals, like the salt of sodium and potassium, and sulphur, 1-4% of carbon remains as carbonate because most carbons are oxidized during pyres. Ashes, flower offering, detergent and soaps when combined with water and pollute the river, which directly and indirectly impacts human health and harms aquatic life. Sustainable management practices are recommended to mitigate the adverse effects and restore the health of this vital water resource.The present study concluded that the Ganga River water was found prone to river water contamination through cremation and other anthropogenic activities at different sampling sites.

The study results recommend regular water quality monitoring and conservation measures in order to protect aquatic life and human livelihood. Further alternate strategies to be adopted to reduce emissions from cremation include the adoption of clean energy sources, the regulation of hazardous components in burial objects, and the optimisation of combustion processes. To get Goal 6 back on track there is need of increased sector-wide investment and capacity-building, promoting innovation and evidence- based action, enhancing cross-sectoral coordination and cooperation among all stakeholders, and adopting a more integrated and holistic approach to water management.

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**Conflict of Interest:** Authors declare that they have no conflict of interest.

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