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Determination of Chloride Concentration in Ami River GIDA Gorakhpur Uttar Pradesh, India.

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Abstract

This research involved measuring the concentration of chloride in the water of the Ami River, selected sites, in water produced from plant liquidation, and in the water used in residential areas in GIDA Gorakhpur. The results illustrate that the highest chloride concentration was found in the water of River Ami in different seasons (rainy, winter, and summer). In the Year 2020-2021, the recorded chloride concentrations in the rainy season (325 mg/l), winter (275 mg/l), and summer (350 mg/l). In the year 2021-2022, the rainy season (375 mg/l), winter (325 mg/l), and summer (400 mg /l) were recorded in the year 2021-2022. The level of chloride in the water of the Ami River was consistent with the BIS standard specification.

Keywords: Chloride concentration, BIS, River Ami, Plant liquidation.

Introduction

Water is the most vital component of the Earth's ecosystem and the most valuable resource in nature. The quality of water environments is intimately correlated to the ecosystem. Fresh and saltwater both contain chloride, which is necessary for life. Salts such as table salt are composed of ions that are bonded collectively when table salt is dissolved in water, its sodium and chloride ions divide as they liquefy. Chloride ions can generate NaCl or other chloride salts, such as potassium chloride, calcium chloride, and magnesium chloride, in the atmosphere that Scientists studying watersheds look for. The chloride ion (Cl^{-}) is a negatively charged chlorine atom (Cl) (CAS No. 7782-50-5, atomic mass 35.45 g/mol) that fusion when the chlorine atom selected up one electron. The chlorine atom is halogen (boiling point of 33.9-C) and never lives in free form in the atmosphere. Chloride ions are the most widespread ions in water environments. Chloride is an ion, especially because it has a negative charge. Chloride is formed from the element. One of the most important inorganic anions or negative ions in both saltwater and freshwater is chloride in the form of Cl^- ions. It originates from the separation of salts such as calcium chloride or sodium chloride in water.

$$NaCl\ (s) \rightarrow Na^+\ (aq) + Cl^-(aq)$$

$$CaCl_2(s) \rightarrow Ca^+\ (aq) + 2Cl^-(aq)$$

The sources of chloride ions sources in water are as follows: chlorine (ClO_2), which bleaches; water flowing through chloride-containing strata; water sources are polluted by industrial wastewater; domestic sewage, in coastal areas, a large amount of seawater enters the water sources due to backwater reason by high tides. High-level concentrations of chloride ions in drinking water make an unpleasant taste and human health harm. High concentrations of chloride ions cause damage to the skin, in human contact with water. Chloride ions polarize in water, and polarized chloride ions can drastically accelerate the corrosion reaction. Chloride ions in water have a corrosive effect on unbreakable concrete, such as those used to accelerate the aging of buildings and bridges. Chloride ions in boiler steam have a caustic effect on boiler pipes and turbine blades Cao *et al.* (2020), He, *et al* (2018) and Yuan, *et al.* (2009). When the chloride ion content is too high in the soil, plant growth is affected, and the sustainability of the biological environment collapses. Chloride ions are essential in living organisms. Chloride ions play an important role in maintaining cell proliferation, the normal function of cells immune response, excitability regulation, and other cellular activities. At the same time, chloride ions are directly associated with numerous physiological and pathological processes in biological bodies. Alhaidary *et al.* (2010) and Zajac, *et al.* (2020). Discharged water from modern industries and household sewage is one source of chloride pollution, Wang *et al.* (2012) and Fang *et al.* (2016). These industries include salt manufacturing, soap, fur processing, alkali, leather, and pickled food industries. The creation of new materials, new forms of energy, and other innovations are another source of Chloride pollution, Kamel *et al. (*2019). Li *et al.* (2021), chloride ion batteries have high conceptual capability and release platforms; they have been reported as one of the implicit technologies which could replace lithium-ion batteries used in cars. But new chloride contamination may occur through battery recycling. Chloride is a compound widely used in agricultural production, industrial and human life, but extreme use will also put damage to the environment and ecosystem. High quantities of chloride can attack and corrode fixtures, reduce vegetation growth, and impede the development of vegetation. Evans and Frick (2001) found that fish are not as susceptible to chloride as tiny free-floating planktonic crustaceans.

The purpose of this study was to determine the chloride concentrations in water samples collected from different sites and seasons in the Ami River.

Chloride analysis in water is important because it is a vital element for the health of animals and plants. High levels of chloride in water can be noxious and have adverse effects on drinking water supplies and aquatic life. Chloride is a basic element in water quality because it plays a significant role in the balance of ions and helps regulate salinity. It is a vital nutrient in plants and helps to regulate osmotic pressure, which can influence the absorption of other nutrients. Chloride also helps maintain the pH balance of water, preventing it from becoming too acidic. In addition, chloride is a natural disinfectant, encouraging the killing of harmful bacteria and providing a safe and clean drinking water supply.

The significance of this study lies in the importance of chloride concentration detection in water quality as it affects the survival of local people, aquatic ecosystems, and animals. The detection of chloride in water is crucial for ensuring water quality, plant and animal survival, and normal industrial production and testing. The Ami River faces pollution owing to industrial impacts and varying values. This research will be useful in determining which industries are polluting the Ami River the most in the future. It also increases public awareness of maintaining River Ami water quality and purity.

Material and Method

Description of the study area

Ami River: Ami River, also known as Gaon ki Ganga, is the lifeblood of the Maghar region and rises near Sikahara Tal in Siddharthnagar. The river flows through Gorakhpur, Sant Kabir Nagar, Basti and Siddharthnagar. The 1989 construction of the Saraya sugar mill at Rudhauli at GIDA near Sahajanwa, IGL, paper mills at Khalilabad, distilleries, and other facilities had a significant negative impact on river water, which used to be rather clear in ancient times. It travels about 102 km before merging with the river Rapti close to the village of Sohgaura in the Gorakhpur tehsil of Bansgaon. A polluted section of the river runs from Rudhauli, Basti, to Sohgaura, and Gorakhpur. According to the data, the river received approximately 12 MLD of sewage. an estimated 5.3 million tons of sewage were produced. On the banks of this section of the river are 37 villages (17 on the left bank and 20 on the right). According to the 2011 census, 42345 people are living in these settlements. Taking decadal growth into account, the predicted population in 2019 was 48,725 and the estimated sewage generation was 5.3 MLD. In the watershed of the concerned stretch of the river ami, there are 12 primary water-polluting industries. These industries have effluent treatment plants and discharge their effluents on land following UPPCB regulations. Three drains were used to release industrial waste into the rivers. One of the three drains was a mixed drain that conveyed both treated industrial waste and untreated sewage.

Sampling Location

The geocoordinates of the village of Bharsar are 26.7199187 and 83.2104426, respectively. This location is close to Adhila bazaar, Adilapar village, which is also very important as industrial effluent from GIDA is discharged through a drain into the river, and the pollution load is high.

Water samples were collected from four (4) different sites of River Ami at GIDA in the rainy, winter and summer. GIDA sector-13, in the village-Bharsar, near Adhila Bazaar. Site- 1- Ramlila Samiti (effluent after treatment)

Site -2 -Situated near Semrahwa Baba Mandir (Just Entry Point into River)

Site -3 -200 Meter up Stream River Ami.

Site -4-200 Meter Downstream River Ami.

Sampling procedure

In the rainy, winter, and summer seasons, sampling was conducted at regular intervals from 7 to 8 in the morning at the study sites. Owing to the loose-fitting silt and stones found in river water, a sample of 2 liters of plastic gallons was taken with utmost care. Thus, the cap was attached to the river itself after the sample bottle was packed into the rim to prevent the entry of unnecessary air bubbles.

Statistical Analysis: Data values were analyzed using mean and standard deviations (mean ±SD), single factor ANOVA of *p* value 0.05 ($p<0.05$) with a correlation matrix significant value in not less than (> 0.05). This study was performed using MS Excel 2007.

Testing procedures for Chloride ions

Code	Product
WT023-1N0	Octo aqua Test Kit (For 8 Test Parameters Water Testing Kit) Octo aqua Kit contains pH strips, color chart for Fluoride, Iron and Nitrate Tests. And 19 Reagents bottles, 1 Test jar with spoon, 4 standard turbidity vials and 1 sample vial.
Reagents	➢ **Reagents: Standard Sodium Chloride Solution**: - 1.648 gram sodium chloride dissolved in 100 distilled water. ➢ Standard silver nitrate. ➢ **Standard Silver Nitrate (0.0282N):-** 4.791-gram silver nitrate dissolved in 100 ml distilled water. And standardized against standard chloride solution. ➢ **Indicator:-** Potassium Chromate Indicator
Procedure	Drop Titration (Method –Comparator) ▼ 10 ml sample in test jar, (jar wash 3 times with sample water for accuracy) ▼ Add. spoon of CH-A ($K_2Cr_2O_7$, indicator), sample get light yellow color ▼ Add. CH-B- (Standard Silver Nitrate titration), titrate the sample again yellow to reddish brown or red in color; count each drop of CH-B.
Calculation	1 drop CH-B=25 ppm or mg/l. (1 drop of CH-B is multiplied by 25)
Limitation	• A uniform sample size must be used. • pH must be 7 to 8 range. • A definite amount of indicator must be used and count every drop of indicator. • Only 100 tests can be done with this testing kit. • Take no less than three readings for each sample. • Protect from sunlight. Store below 30°C temperature.

Result and Discussion

The observed values of the chloride concentration reported in the river Ami at several sites and in different seasons are shown in (table.1). The maximum values measured in 2020-2021 during the rainy season were 325 mg/L and 250 mg/L, respectively. The maximum chloride concentration recorded was 400 mg/L in the year 2021-2022, while the minimum was 375 mg/L. in the year 2020-2021, the ami-river chloride level was observed to range between 250 and 350 mg/L. All readings exceeded both the WHO maximum and permissible levels and the BIS recommended limit of 250 mg/L but were within the permitted upper range (600 mg/L). The high concentration of chloride downstream (Site-3) may be due to the outflow of domestic garbage, which may be highly chloride-containing. (2013). Bohlke (2002) listed how chloride enters natural water, including chloride in solution with minerals and rocks, and pollution from wastewater that comes from industries, households, and agricultural practices. Gebreyohannes *et al.* (2015) expanded this information.

Table 1. Chloride concentration in river Ami water samples.

Sampling Sites										
Season	2020-2021				2021-2022				BIS	
	Site-1	Site-2	Site-3	Site-4	Site-1	Site-2	Site-3	Site-4	Desirable	Max. Permissible Limit
Rainy	325 mg/L	300 mg/L	271 mg/L	250 mg/L	375 mg/L	350 mg/L	325 mg/L	300 mg/L	250 mg/L	600 mg/L
Winter	275 mg/L	250 mg/L	275 mg/L	250 mg/L	325 mg/L	300 mg/L	300 mg/L	275 mg/L	-	-
Summer	350 mg/L	325 mg/L	325 mg/L	300 mg/L	400 mg/L	375 mg/L	350 mg/L	325 mg/L	-	-
Mean	316.66	291.66	2291.66	266.66	366.66	341.66	325	300	-	-
Standard deviation	31.18	31.18	23.57	23.57	31.18	31.18	20.41	20.41	-	-

The amount of chloride in this study ranged between 375 and 400 mg/L in the years 2021-2022, exceeding the BIS acceptable limit of 250 mg/L. A comparison of these levels is presented in (Figures 1 and 2). In all three seasons, was higher at site 1(effluent after treatment). Chloride is a contaminant only at higher concentrations and is discharged in effluents because of the use of substances such as hypochloric acid and chlorine gas during bleaching, washing, and disinfection procedures. It is a critical anion in industrial effluents that affects crops (Varma and Sharma, 2011). It kills microorganisms in water, disrupts the aquatic food cycle, increases corrosiveness, and may have negative health consequences. It also affects the electrical conductivity, alkalinity, TSS, TDS, and sulfate levels. Because of the increased mineral content, chloride concentrations above 250 mg/L impart a salty flavor to water. According to Manikandan *et al.* (2015), the concentration of chloride in effluents assembled from Tirupur textile factories ranges between 145 and 1668 mg/L. Chlorine, a substance used as an indicator of pollution, was generally detected below the allowed level of 250 mg/L in the study area. Water with an excess amount of chloride (250 mg/L) tastes salty, and people who are not accustomed to high chloride levels may experience laxative effects. The highest (275 mg/L) and lowest (250 mg/L) concentrations were reported in the winter of 2020-2021. The largest and minimum values were 325 and 275 mg/L, respectively, in winter. The maximum and lowest values for the summer of 2020-2021 were 350 and 300 mg/L, respectively. A maximum value of 400 mg/L and a low value of 325 mg/L were recorded for the next year 2021-2022. High quantities of these chlorides may originate from runoff from industrial locations, contributing to water contamination. According to these findings, Class C is the group in which all chosen sites fall. Amrendra *et al.* (2017) found that the levels of chloride in all samples taken from GIDA sectors 5 and 13 of the industrial area were between 33 mg/L and 91 mg/L, which was below the BIS permitted limit. Chloride concentration in effluents was 487.94 mg/L, according to Patel *et al.* (2017), the chloride concentration in effluents taken from the Ahmadabad Mega Pipeline. A higher concentration of chloride in the water can also increase the risk of eutrophication, a process where too much nitrogen and phosphorus feed on algae and other aquatic plants, causing algal blooms that can deplete the water oxygen (dissolved oxygen) supply and cause fish deaths. To ensure that the effluents are free of such dangerous contents and that aquatic life is not harmed, it is necessary to identify a treatment method for such samples and to establish a common policy that applies to all industries.

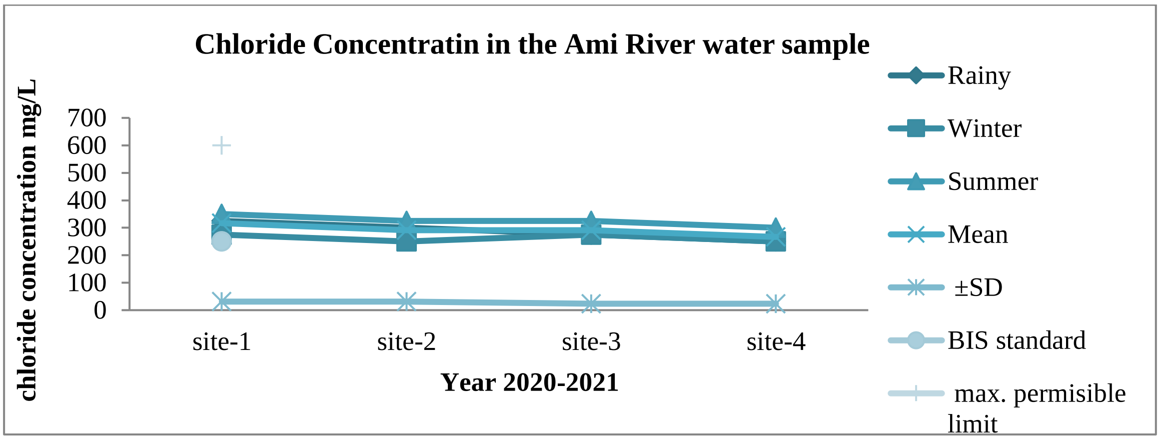

Figure 1 Level of chloride concentration in river Ami water samples, (2020-2021).

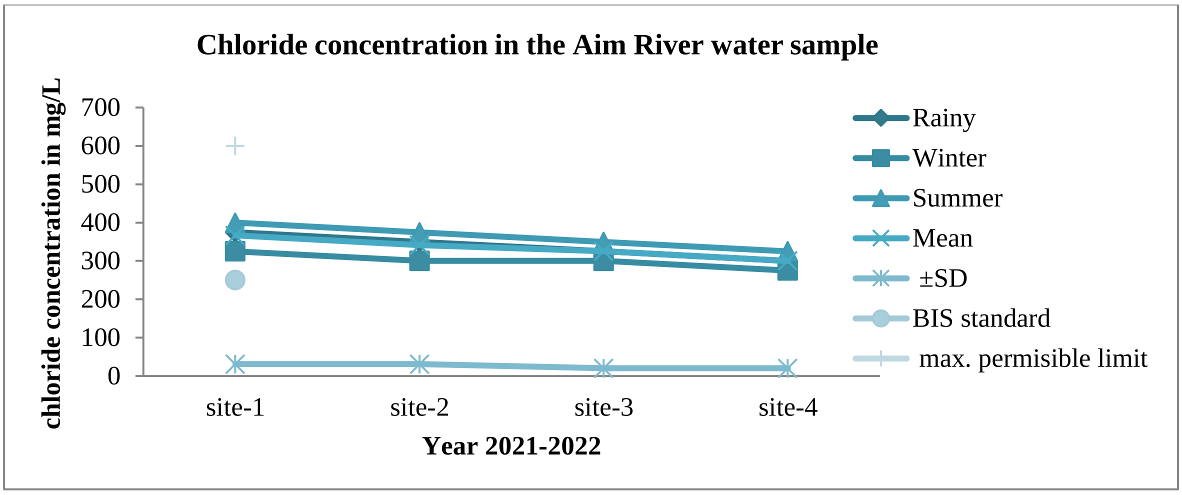

Figure2. Level of Chloride Concentration on River Ami Water Sample. (2021-2022).

Table 2. Single-factor ANOVA, for chloride concentration in 2020-2021

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	7916.667	2	3958.333	7.125	0.01397	4.256495
Within Groups	5000	9	555.5556			
Total	12916.67	11				

Table 3. Single-factor ANOVA for chloride concentration in the year 2021-2022

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	7916.667	2	3958.333	4.75	0.039068	4.256494729
Within Groups	7500	9	833.3333			
Total	15416.67	11				

According to the ANOVA results, there was a statistically significant difference between the mean values of chloride concentration at each of the four sites and in each of the three seasons. Given that the statistical *F-value* in (table-2) is more than the critical *F*-value and the probability value (*P*-value) is 0.01, and the statistical *F*-value is 7.125, the result is very significant. Because the statistical *F-value* in (table-3) is higher than the critical *F*-value, which is 4.25, and because the *P*-value is 0.3, the result is highly significant. Accepting the null hypothesis (H_0) for both years of chloride concentration. An extremely significant difference in the mean chloride content is a hypothesis that is being investigated.

Table 4. Pearson's Correlation matrix in rainy, winter and summer (2020-2021)

	Rainy	**Winter**	**Summer**
Rainy	1		
Winter	0.447214	1	
Summer	0.948683	0.707107	1

Table 5. Pearson's Correlation matrix in rainy, winter and summer (2021-2022)

	Rainy	**Winter**	**Summer**
Rainy	1		
Winter	0.948683	1	
Summer	1	0.948683	1

Determination of correlation matrix

The correlation coefficient measures the two interdependent variables. In this study, the Pearson correlation coefficient was calculated among the chloride concentrations. The linear interdependence between the two variables was measured using Pearson correlation. Both positive and negative linearities of dependence can be observed. In general, the value of the Pearson coefficient ranges from -1 to +1. When the two variables have a value of -1, they are said to have a negative linear correlation, and when they have a +1 value, they have a positive linear correlation. If the value is zero (0), there is no correlation between the variables (Kirch, 2008). The value is the probability of the statistical significance of the correlation between the variables. The convention is presented in (table.6.).

Table 6. Pearson's correlation degree of correlation positive and negative correlation

Degree of correlation	Positive	Negative
1. Perfect correlation	+1	-1
2. Very high degree of correlation	More than +0.09	Less than -0.09
3. Sufficiently high degree of correlation	More than +0.75 (+0.75 to 0.09)	Less than -0.75 (-0.75 to 0.09)
4. Moderate degree of correlation	More than +0.6(+0.6 to 0.75)	Less than -0.6(-0.6 to 0.75)
5. Only the possibility or correlation	Less than +0.3 (+0.30 to 0.60	Less than -0.3 (-0.30 to 0.60
6. Possibility of no correlation	Less than +0.3	More than -0.3
7. Absence of correlation	0	0

In the year 2020-2021(table-4), the rainy chloride concentration was only correlated with winter chloride concentration (0.44), with a high correlation with summer chloride concentration (0.94), perfect correlation with rainy chloride concentration (+1), and moderate correlation with summer chloride concentration (0.70), in the year 2021-2022 (table-5), the rainy chloride concentration was highly correlated with the winter chloride concentration (.0.94), with a high degree of correlation with summer chloride concentration (0.94). The Pearson correlation coefficient was positive and significant, suggesting that anthropogenic and industrial activities were responsible for the contamination of surface water in the study area.

Conclusion

The analysis of chloride concentration in River Ami water quality revealed that it follows the BIS and WHO permissible limits. The river water quality conforms to class A water before Rudhauli, where industrial effluents from distilleries, paper mills, and sugar mills mix with natural water. Nonstop aggravation was observed at Khalilabad Rayna paper mill Sahajanwa (close to IGL) and village Adilapar, where the GIDA drain discharges into the river. River deterioration due to industrial pollution has resulted in its conversion into the river Ami below class-E. Recent projects involving the Namami Gange have been overseen by the NGT and Uttar Pradesh Pollution Control Board (UPPCB). An STP was installed in Maghar. Invent the reuse of industrial effluents by treating them in industry installed STP. The government bans dumping outside industries, promotes reuse, and uses common treatment plants to control the toxic content.

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تحديد تركيز الكلوريد في نهر آمي جيدا جوراخبور أوتار براديش ، الهند

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المستخلص

تضمن هذا البحث قياس تركيز الكلوريد في مياه نهر آمي، ومواقع مختارة، في المياه المنتجة من تصفية النبات، وفي المياه المستخدمة في المناطق السكنية في جيدا جوراخبور .توضح النتائج أنه تم العثور على أعلى تركيز كلوريد في مياه نهر عامي في مواسم مختلفة) ممطرة وشتاء وصيف .(في العام**2020-2021** ، سجل تركيز الكلوريد المسجل في موسم الأمطار **325)**ملغم / لتر (والشتاء **275)** ملغم / لتر (تركيز كلوريد، والصيف **350)** ملغم / لتر .(في العام 2021-2022 ، تم تسجيل موسم الأمطار **375)** مجم / لتر (والشتاء **325)** مجم / لتر (والصيف **400)** مجم / لتر (في العام **.2021-2022** كان مستوى الكلوريد في مياه نهر آمي متسقا مع المواصفات القياسية لبنك التسويات الدولية .الكلمات المفتاحية **:**تركيز الكلوريد،**BIS** ، نهر عامي، تصفية النبات**.**