Mini Project Report

On

DETERMINATION OF WATER QUALITY INDEX OF SURFACE WATER QUALITY IN MORI KOLONG BEEL, NAGAON, ASSAM

A dissertation

submitted in the partial fulfillment of the requirement for the Award of the Degree of

MASTER OF TECHNOLOGY
In
CIVIL ENGINEERING
(*With specialization in Water Resources Engineering*)
Of
Assam Science & Technology University
Session: 2023-2025
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CANDIDATE DECLARATION

(Session: 2023-2025)

I hereby declare that the work presented in the dissertation entitled **"DETERMINATION OF WATER QUALITY INDEX OF SURFACE WATER QUALITY IN MORI KOLONG BEEL, NAGAON, ASSAM"** in the partial fulfillment of the requirement for the award of the degree of Master of Technology in Civil Engineering with specialization in Water Resources Engineering submitted in the Department of Civil Engineering, Assam Engineering College, Jalukbari, Guwahati-13, under Assam Science and Technology University has been carried out by me under the supervision of Dr. Bipul Talukdar, Professor, Department of Civil Engineering, Assam Engineering College, Guwahati. Whatever I have presented in this report has not been submitted by me for the award of any other degree or diploma.

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(Session: 2023-2025)

This is to certify that the work contained in the report entitled "**DETERMINATION OF WATER QUALITY INDEX OF SURFACE WATER QUALITY IN MORI KOLONG BEEL, NAGAON, ASSAM**" has been carried out by Kartik Kalita, Roll No:230620061010 a student of M. Tech 3rd semester in the Department of Civil Engineering, Assam Engineering College, Guwahati, under my guidance and supervision and submitted in the partial fulfillment of the requirement for the award of degree of Masters of Technology in Civil Engineering with specialization in Water Resources engineering under Assam Science and Technology University.

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NOTATIONS

Symbols	Description
BIS	Bureau of Indian Standards
IS	Indian Standards
KM	Kilometer
WHO	World Health Organization
$CaCO_3$	Calcium Carbonate
pH	Hydrogen-ion concentration
Cl	Chloride
Fe	Iron
F	Floride
D.O	Dissolved Oxygen
B.O. D	Biological Oxygen Demand
NO_3	Nitrate
GPS	Global Positioning System
Mg/l	Milligram per litre
PPT	Parts per trillion
PPM	Parts per million
WQI	Water Quality Index
WQP	Water Quality Parameter
WAWQI	Weighted Arithmetic Water Quality Index

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ABSTRACT

Mori Kolong Beel is a prominent and popular wetland located in the heart of Nagaon Town in the state of Assam. Mori Kolong Beel is known for its rich biodiversity. Mori Kolong is one of the largest wetlands of Nagaon district situated in the middle Brahmaputra valley of Assam. It is formed by the abandoned path of the river Kolong during the course of time. However, increasing pollution and other anthropogenic activities have led to the deterioration of the water quality of this very wetland. The present study was carried out to analyze the water quality parameters of the Beel and check the correlation that existed among various parameters. The present study was carried out to analyze the 13 physicochemical water quality parameters of the Beel. A total of thirteen parameters viz. pH, Turbidity, Total Hardness, Total Alkalinity, Chloride Content, Total Dissolved Solids, Fluoride, Sulphate, Magnesium content, Calcium content, Conductivity, Iron content, and Nitrate content were tested for six sampling locations in and around the areas of Mori Kolong Beel. The samples for testing were collected at 6 locations around the Beel in order to note the difference in results among the different sites. Standard methods were followed for the collection, sampling and analysis of the water quality parameters. Moreover, Water Quality Index for all 6 sampling sites calculated to classify the water quality according to the degree of purity with the help of the measured water quality parameters.

Key words: *Physio-chemical parameters, water quality analysis, Mori Kolong Beel, Nagaon District, Weighted Arithmetic Index Method, WQI*

CHAPTER 1

INTRODUCTION

1.1. GENERAL

The Brahmaputra valley of Assam is blessed with numerous waterbodies and swamps. The natural waterbodies are locally called as “Beel” while the swamps are known as “Jalah”, “Doloni”, Pitoni”, “Duba” or “Hola”. All these are as a whole termed as wetland. These wetlands are geomorphologically and ecologically very important features. These comprise a major component of the hydrologic regime of the state. They act as storage basins during flood and thereby reducing the impacts of the flood. Wetlands are home of various aquatic flora and fauna and provide a good example of an aquatic ecosystem. Besides the socio-economic value of the wetlands is also significant. These beels are traditionally used as the natural fisheries of Assam. Mori Kolong is one of the largest wetlands of the Nagaon district situated almost nearby the township area. In fact, it is an ox bow lake formed due to the changing course of the Kolong river. It is almost 7 km long. The Mori Kolong wetland is one of the largest wetlands of Assam situated in the south bank flood plains of mighty Brahmaputra in Nagaon district. Its location is just 1.5 km from the Nagaon main town in the south direction along the 36 National Highway. It extends from 26º19´N to 26º22´N and 92º40´E to 92º43´ E. Its elevation is 60.6m from the mean sea level. The physiography of the Mori Kolong area is plain with a very gentle slope. Due to various earthquake from 1670 to 1950 the Kolong river changes its course from time to time. As a result of the shifting of the course of the river, this wetland has got origin in the sub urban zone of the Nagaon town.

Figure 1.1 and 1.2: Image showing Mori Kolong Beel

1.2. OBJECTIVE OF THE STUDY

The objectives of this study are:

1. To study the cause behind the contamination of sites in and around the Mori Kolong Beel.

Investigate and analyze the causes of contamination at various locations within and around the Mori Kolong Beel. It would include identification of possible sources of pollution, which might be through industrial discharge, agricultural runoff, untreated sewage, or other human or natural activities. The study aims to understand the extent of contamination, its impact on the local environment, aquatic life, and communities relying on the beel, as well as to propose mitigation strategies for preserving the ecosystem health.

2. To carry out a systematic water quality analysis to know the water quality of the water body.

The objective is to gain a detailed understanding of the current state of the water quality, identify any deviations from acceptable standards, and evaluate the potential impact on aquatic life, surrounding ecosystems, and human usage of the water resource. This elaboration provides greater detail about the scope and purpose of the analysis.

3. To determine the most potential parameter/factor responsible for the aforesaid effect of water quality deterioration.

Identify and analyze the primary parameter or factor that significantly contributes to the observed deterioration of water quality. This involves evaluating various influencing elements such as industrial effluents, agricultural runoff, heavy metal contamination, microbial pollution, changes in pH, dissolved oxygen levels, or nutrient overloading. Through data collection and statistical analysis, the study aims to pinpoint the dominant cause(s) of water quality degradation, enabling focused remediation efforts to address the root issue effectively and prevent further environmental harm.

CHAPTER 2

LITERATURE REVIEW

- **S. N. Thitame et al. (2010)** have studied, in the present investigation an attempt was made for assessment of Seasonal Variation in Physicochemical Characteristics and Quality of Pravara River Water for Irrigation during the year 2008. The study reveals that most of the physicochemical parameters of river water at five selected sites show moderate variation in their concentration for all seasons. However, sites 3 and 4 stands as evidence of the discharge of wastewater from the city in the river. This intern indicated the quality of water for irrigation in the study area. The Sodium absorption ratio and Residual sodium carbonate values show good water quality for irrigation. However, at site 3 and 4 the values of Kelly's index and Soluble Sodium Percentage exceed their standards in monsoon season indicating doubtful quality of water for irrigation.

- **Jadhav et al. (2012)** have explained, in order to understand the water quality of Triveni Lake, Physico-chemical parameters were studied and analyzed for the period of one year i.e., December 2010 to November 2011. Various physicochemical parameters, such as water temperature, air temperature, pH, humidity, conductivity, free Co2, total solid, dissolved oxygen, Total alkalinity, Total hardness, $CaCo_3$, Ca^{2+}, Mg^{2+} were studied. The results revealed that there was significant seasonal variation in some physicochemical parameters and most of the parameters were in normal range and indicated better quality of lake water. It has been found that the water is best for drinking purpose in winter and summer seasons.

- **Thukral A K. et. al (2014)**, in his journal paper, studied the characterization of change in Harike wetlands using Landsat satellite data. Their study was focused on reduction in the area of the wetland due to the pressure implemented because increasing human interventions such as urbanization, agricultural land expansion, etc. The study was carried out through data collected from Landsat satellite from 1989 to 2000 and another period extending from 2001 to 2010. The satellite images of Landsat TM and ETM of the study area were obtained from the USGS (source: http://glovis.usgs.gov/). In their study, the classification of the images was divided under five land cover types: Waterbody, Wetland I, Wetland II, Barren land and Agricultural areas. The classified images obtained were compared with GPS, topographical sheets and available wetland maps of the study area, to determine how each site represented on the ground as observed during ground surveying for verification. All image processing was performed using ERDAS Imagine 9.1, and ArcView GIS 3.2. Wetland maps were prepared in ERDAS imagine and Surfer 8. An e-Trex, Garmin Global Positioning System (GPS) receiver was used to determine the geo-coordinates of a given area in terms of its latitude and longitude. From detailed review of their image comparisons, it was noted that there was significant change in area of wetland since 1989 as well as changes were observed in the water levels during the period from 1989 to 2010. More specified results showed that the wetland classes decreased from 82% (7154 ha) in 1989 to 71% (6195 ha) in 2000 and gradually to 69% (6020 ha) in 2010 indicating towards shrinking of wetland area. A total of thirteen percent of the wetland area was lost between 1989 and 2010. Barren land and Agricultural land were the non-wetland classes, which area increased significantly from 18% (1585 ha) in 1989, increasing to 29% (2544 ha) in 2000, and subsequently to 31% (2718 ha) in 2010. This study indicated towards the decreasing of the wetland area, which will have a significant effect on the water quality status as well as the lifeforms presented in the habitat.

○ **A. Kumar et al. (2015)** Evaluation of water quality of Ganga River using Water Quality Index tool to analyze water samples from five designated locations along the river (Rishikesh to Allahabad) using Weighted Arithmetic WQI Method to measure various physio-chemical parameters and to observe trends in the water quality downstream and correlate these with environmental pollutants to understand how local factors contribute to water quality deterioration.The results point to the significant consequences of mindless anthropogenic activities and poorly regulated industrial discharges along the river. They found that, using WQI calculation the study reports a significant trend of degrading water quality along the downward path of the river which may serve as a guide to planning strategies to control pollution.

○ **Bhaswati Dutta and Bibhash Sarma (2018)** A study was carried out on assessment of Water Quality Index of the Kolong River of Nagaon District of Assam using Weighted Arithmetic WQI Method to analyze the Water Quality Index (WQI) and examine the variations in WQI parameters during the pre-monsoon period (March-April), after the breaching of the Hatimura dyke in 2017. They found that Kolong River water quality is unsuitable for direct consumption but can be used for transportation, irrigation, and agricultural purposes and must be treated before use to avoid related diseases. They found that this quality of river water may cause harm to the sensitive aquatic life and aqua-environment so regular monitoring of the river is required.

- **A.S.N Zaman et al. (2018)** A study was carried out on the assessment of Mora Kolong Beel of Morigaon District of Assam to understand the water quality of the Beel. Physico-chemical parameters were studied and analyzed for the period of one year i.e., February 2017 to January 2018. Various physicochemical parameters, such as water temperature, water depth, air temperature, Turbidity, pH, humidity, conductivity, free Co2, total solid, dissolved oxygen, Total alkalinity, Total hardness, CaCo$_3$, Ca^{2+}, and Mg^{2+} were studied. The results revealed that there was significant seasonal variation in some physicochemical parameters and most of the parameters were in a normal range and indicated better quality of lake water for aquatic life. It has been found that the water is not for drinking purposes in all seasons.

- **Akumtoshi Lkr et. al (2020)**, in their article "assessment of water quality status of Doyang river, Nagaland, using water quality index", investigated water quality index of Doyang river in three different seasons throughout a year. Sampling was done during the first week of each month from eight selected stations of the river. They categorized the months into three different seasons namely pre-monsoon (PRM), monsoon (MON) and post-monsoon (POM) for data interpretation. In this study twelve physicochemical parameters like P^H, EC, TDS, total alkalinity, total hardness, Ca^{2+}, Mg^{2+}, Cl$^-$, NO$_3^-$, SO$_4^{2-}$, chemical oxygen demand (COD), biochemical oxygen demand (BOD), dissolved oxygen (D.O.), sulphate (as SO4 2-), nitrate (as NO3) and chloride (Cl-) levels .Some heavy metals like Iron, Zinc, Cadmium, Mercury, Nickel and Chromium were also analyzed in these samples. There were variations for EC (141-1041 "#$% &), turbidity (2-9 NTU), TDS (107.1–935.8 mg/L), SO4 2- (4– 8 mg/L), TA (42–410 mg/L), TH (41-280 mg/L), Ca–H (14- 10 mg/L), BOD (5-9mg/L), COD (4– 32 mg/L) NO3(1.1-3.6 mg/L) and Cl- (49-167 mg/L) levels at different sites. Water pollution indicates that these parameters were manifold higher than the prescribed limit by the WHO & BIS standard. Wu-Seng Lung, A. M. Asce [04] has studied, a two-layer time-variable model is developed to quantify seasonal variations of pH and alkalinity levels in acidic lakes. The model incorporates the CO2/ HCOJ/ CO5 equilibrium with internal sources and sinks of alkalinity and acidity in the water column. External alkalinity and C0$_2$ acidity loadings are also incorporated. The modeling framework is applied to the Bickford Reservoir in Massachusetts and to Woods Lake and

Panther Lake in Adirondack Park, New York. In general, in-lake alkalinity generation by reduction processes in the Bickford Reservoir during the summer months is simulated by the model. The observed response to snowpack release in Woods Lake and Panther Lake during the spring months is also reproduced by the model. All three model applications are efficiently run on a personal computer system.

- **Ritabrata Roy and Meinmoy Majumder (2021)** A study was carried out on the assessment of water quality trends in Deepor Beel using the Weighted Arithmetic WQI method to assess and analyze the water quality of Deepor Beel, a Ramsar Site in Assam, India, over three years using different Water Quality Indices (WQIs). The study aims to evaluate the qualitative and quantitative trends in the water quality of the lake, identifying its environmental and economic significance for local livelihoods. The research concludes that the water quality of the lake is generally fair, with deterioration observed during summer and post-monsoon periods, and highlights the need for better management plans to sustain the lake's ecological health.

CHAPTER 3

WATER QUALITY PARAMETERS

3.1 INTRODUCTION:

Water quality refers to the physical, chemical and biological characteristics of water in relationship to a set of standards (Wikipedia). For utilization of water for various purposes, the used water should meet certain requirements in its standard. Thus, the suitability of water to support and sustain the requirements as well as various processes is termed as water quality. Quality analysis of water is a very important tool or monitoring and updating the limits of water parameters for proper maintenance of environmental balance, like the limits for concentrations of toxic substances for use of drinking water restrictions of temperature to ranges of temperatures and pH in waters supporting communities of invertebrates. Usually, surface and ground water amount to the overall water resources available. The water quality of different location available on earth may not be same. The deterioration or variation in limits of the quality of water may occur due to natural factor as well as human influences. The most important of the natural influences are geological, hydrological and climatic, since these affect the quantity and the quality of water available. The purest form of water is considered to be rain water. But, in the process of precipitation, the rain water absorbs dissolved gases from the atmosphere and becomes polluted. Rain water after precipitation comes into contact with impurities present on the ground and it percolates underground and hence contaminates the ground water quality. Again, during volcanic eruptions underwater some poisonous gases may come out and thus causing variation in the parameters of water thereby affecting the water quality. In arid and coastal areas, high salinity of water is a natural problem.

Human activity is the worst factor affecting water quality. Human activities pollute groundwater and groundwater through extensive interference with all natural resources, without adequate control measures to maintain the quality of the water resources. Fuel and storage leaks, road salt deposits and more Water quality degradation will equally impact aquatic ecosystems and the environment including humans. Thus, a comprehensive and extensive water quality assessment should be conducted to assess the limitations of the standards and conserve water quality by developing strategies.

3.2 WATER QUALITY STANDARDS:

In the setting of standards, agencies make political and technical/scientific decisions about how water will be used. In case of natural water bodies, they also make some reasonable estimate of original and fresh conditions. Water quality in this project is used with reference to a set of guidelines values and standards set by World Health Organization (WHO) and Bureau of Indian Standards (BIS).

3.3 WATER QUALITY PARAMETERS:

The parameters defining, he quality of water can be sectioned into different categories or types. A brief explanation about their characteristics and measurement techniques is put forwarded as follows: -

1) Physical parameters.

2) Chemical parameters.

3) Biological parameters.

3.3.1 PHYSICAL PARAMETERS:

The important physical parameters of water include turbidity, colour, odour, temperature, electrical conductivity (EC), total dissolved solids (TDS), viscosity, specific weight and vapour pressure.

Temperature:

Temperature measurement in water does not directly imply to whether water is polluted or not. But, temperature of water affects some of the important properties and characteristics of water such as density, specific weight, viscosity, surface tension, solubility of dissolved gases and etc. Chemical and biological reaction rates increase with increasing temperature. Reaction rates usually assumed to double for an increase in temperature of 10 °C. Dissolved oxygen is indirectly related to temperature, as temperature increases D.O of water decreases. Increase in temperature increases the growth rate of aquatic microorganism which leads to higher consumption of consume dissolved O_2 and level of dissolved O_2 decreases. Moreover, temperature also affects disinfection process because efficiency of disinfection is lower at lower temperature.

Colour:

Pure water is colourless. Appearance of any colour in water points towards presence of polluted materials in water. Natural water system is often colored by foreign material. Colour in water is imparted mainly due to dissolved materials and suspended materials. If the colour is due to suspended material, it is called as apparent colour. Colour given by dissolved material that remains even after removal of suspended material is called true colour or real colour. The maximum acceptable level of colour in water is 15 TCU (True Colour Unit). Objections to high colour are generally on aesthetic grounds rather than on the basis of a health hazard.

Odour and Taste:

Drinking water should be tasteless and odourless. Odour in water indicates water pollution. Odour and taste may develop in water due to natural and anthropogenic effects. Disinfection process of water might give out some taste and odour in water supply. Some natural impurities dissolved in water can also give taste and odor. Inorganic salts such as NaCl, KCl, etc. dissolve in water give taste whereas compounds like H_2S can give both taste and odour.

Odour is measured in T.O.N (Threshold Odour Unit). For, drinking standards odour should be less than 3 T.O.N.

Turbidity:

Turbidity is opaqueness of water. It is the measure of resistance offered by the suspended particles to the passage of light through water. the degree of which water losses its transparency due to presence of suspended particulates. Water will be rate as highly turbid if the concentration of suspended particles is more. Turbidity is often used as an indicator to check quality of water based on clarity and concentration of suspended solids in water. Presence various factors increases the turbidity of water such as- suspended sediments like clay or silt, re-suspended sediments from bottom of a water body, dumped waste and other discharges, phytoplankton, algal growth etc.

Turbidity is a surface phenomenon. The sunlight is reflected and cannot penetrate deep due to the presence of suspended matters as a result it reduces the photosynthetic activities of certain plant species underneath. Moreover, the suspended solid particles absorb the heat from the sunlight, which makes the turbid water warmer, and so reducing the concentration of oxygen in the water, which directly affects the survival of the aquatic organisms. Turbid water appears to be murky, cloudy and dirty from esthetic view. For proper disinfection removal of turbidity of water is important.

Earlier, turbidity is measured on silica scale and expressed in terms of Turbidity Units (T.U). Jackson Turbidity Unit was used which work on the principle of light absorption. Nowadays, Instrument which is used to measure turbidity is called ‘Nephelometer’. Nephelometer is a digital electronic device which works on the principle of light scattering and measure very low turbidity in water with high degree of precision instantly. It measures turbidity in terms of Nephelometric Turbidity Units (N.T.U). The instrument always takes into account the amount of light scattered perpendicular to the incident ray (90 degrees to the light path) to measures turbidity.

1 N.T.U = 1mg of formazin polymer mixed in 1 litre of distilled water, then the turbidity produced is 1 N.T.U

Total Dissolved Solids (TDS):

Total Dissolved Solids is the measure of the mass of solid material dissolved in a given volume of water. TDS is measured in grams per litre. Total dissolved solids include inorganic salts (mainly salts of calcium, magnesium, sodium, bicarbonates, chlorides ad sulfates) ad dome small amounts of organic matter that are dissolved in water. The sources of TDS comprise of natural sources, urban run-off, industrial wastewater, sewage, chemicals in water treatment process etc. TDS test provides a qualitative measure of the number of dissolved solids present in the water sample. The presence of TDS is not a health hazard but concerned with the aesthetics of water. The limit for drinking water standards of TDS is set for not greater than 500 mg per litre. But a higher TDS level indicates the presence of certain cations and anions in relation with the water quality parameters:

(i) Cations combined with carbonates of $CaCO_3$, $MgCO_3$ etc. indicates hardness, scale formation, bitter taste in water.

(ii) Cations combined with Chlorides like NaCl, KCl results in salty or brackish taste and increase corrosivity of water.

TDS test is done generally through two methods: Gravimetric analysis and Electrical conductivity.

Gravimetric analysis is the most accurate methods and involve evaporating the liquid solvent ad measuring the mass of residues left. Although, this method is very time consuming, but it provides more reliable results. This method is applicable for measurement of total dissolved solids I all natural waters, in raw, process and treated agricultural, municipal and industrial wastewaters and in treated drinking water. Electrical conductivity is a measure of the capacity of water to conduct electrical current. Conductivity is directly related to the concentration of salts dissolved in water and thereby directly linking to the Total Dissolved Solids. The measure of TDS I the field directly is difficult, so its measurement is done through the conductivity method. Electrical conductivity is a fast method which ca be measured using a conventional conductivity meter or TDS meter.

Electrical conductivity ca be related to TDS with the help of the following equation:

$$TDS = k_e.EC$$

where, TDS is expressed in mg/litre.

EC is measured I terms of micro-siemens per cm.

k_e is the correlation factor which ranges from .55 to .80.

3.3.2 CHEMICAL PARAMETRS:

Water quality is most affected by the chemical matters preset in it. Chemical parameters may include organic and inorganic matters. Some of the concerned chemical parameters include water pH, Total Hardness, Calcium Hardness, Magnesium Hardness, Alkalinity, presence of Chloride, Fluoride, Iron, Arsenic, Lead, Nitrate etc. The chemical parameters which are investigated in this study are listed below:

Hydrogen-Ion Concentration (pH):

The pH is a quantitative measure of the hydrogen ion concertation of water indicating the measurement of the acidity or alkalinity of a solution. The pH scale generally rages from 0 to 14.

The pH scale indicates: water is acidic if pH is less than 7 water is neutral if pH is equal to 7 water is alkaline if pH is greater than 7 pH is calculated as the negative logarithm of the hydrogen ion concertation, i.e., pH=-$\log_{10}$[H]. It is measured in units of moles per litre, of hydrogen ions. The normal rage for pH in drinking water is between 6.5 to 8.5 (as per IS 10500:2012). The pH of pure water is considered to be 7. The effect of pH is not direct o to our health. When pH level is less than 6.5 it increases acidity resulting in metallic or sour taste of drinking water, blue-green staining of sinks and other household fixtures. Moreover, with increase of pH indicates alkaline water which results in scale buildup in household plumbing.

pH can be measured by two techniques: colorimetric and potentiometric. The colorimetric method involves adding a suitable indicator to a solution ad matching the colour of the solution to a standard solution containing the same indicator. But potentiometric method is more accurate. This method uses a pH meter to determine hydrogen ion concentration having two electrodes. The electrodes potential of the indicator electrode is linearly related to changes in hydrogen ion concentration and thus pH is known.

Total Hardness (TH):

The characteristics of water that prevents formation of lather or foam with soap is termed as the harness of water. Water which has high dissolved minerals in it, generally calcium and magnesium is considered hard. As water moves through soil and rock, it dissolves very small amounts of minerals and holds them in solution. The degree of hardness becomes greater as the calcium and magnesium content increases in the water. Hardness of water is generally of two types:

(i) Carbonate or temporary hardness: The bicarbonates and carbonates of calcium and magnesium usually causes this type of hardness. Temporary hardness can be removed to some extent by boiling or removed fully by addition of lime.

(ii) Non-carbonate or permanent hardness: Permanent hardness is primarily caused by presence of calcium chloride, calcium sulphate, magnesium chloride or magnesium sulphate. It cannot be removed by boiling, and some special treatment is required for its removal. Non-carbonaceous hardness can be removed by water softening methods such as lime soda process, demineralization process and zeolite process.

Total hardness is the sum of the carbonate harness and non-carbonate hardness. It is measured in terms of parts per million(ppm) or mg/litre of $CaCO_3$.Water is considered soft when the concentration of $CaCO_3$ is below 60 mg/l; moderately hard when between 60-120 mg/l; hard when between 120-180 mg/l and very hard when more than 180 mg/l. Hard water is not a health hazard but it has serious impacts on household items. Water hardness causes damages to boilers, cooling towers and other equipment that handles water. Hard water can cause mineral build-up in water pipes and eventually clog them. Total hardness is measured by EDTA (Ethylene Diamine Tetraacetic Acid test).

Alkalinity:

The alkalinity refers to the measure of the capacity of the water to neutralize the acids. Alkalinity of water may be due to the presence of one or more of a number of ions. These include hydroxides, carbonates and bicarbonates. Most alkalinity in surface water comes from calcium carbonate ($CaCO3$) that come from rocks and soil. Limestone contains high level of calcium carbonate. The process is enhanced if the rocks and soil have already been broken up before entering the water. The dissolved minerals get into the water through construction and other processes. In simple terms, the pH of a solution is a measure of how strong the bases are in a solution, whereas the alkalinity measures the amount of chemical bases present in the solution. Alkalinity is determined through titration. It is usually measured in unit of mEq/L (milliequivalent per litre).

Normal drinking water generally has a neutral pH of 7. Alkaline water typically has a pH of more than 8. But pH alone isn’t enough to impart substantial alkalinity to water. Although alkaline drinking water is considered safe, it has some side effects including the lowering of natural stomach acidity, which helps kill bacteria and expel other undesirable pathogens from entering your bloodstream. Additionally, an overall excess of alkalinity in the body may cause gastrointestinal issues and skin irritations. Alkalinity is usually measured in unit of mEq/L (milliequivalent per litre).

Chloride (Cl):

Chlorides are salts resulting from the combination of the gas chlorine with a metal. Some common chlorides include sodium chloride ($NaCl$) and magnesium chloride ($MgCl_2$). Chloride exists in all natural waters, the concentrations varying very widely and reaching a maximum in sea water (up to 35,000 mg/l Cl). In fresh waters the sources include soil and rock formations, sea spray and waste discharges. Chloride contents are very high in sewage and industrial effluents. Chloride does not pose a health hazard to humans under standard limits. Public Drinking Water Standards require chloride levels not to exceed 250 mg/L. Water will begin to taste salty and will become increasingly objectionable as the concentration level rises further above 250 mg/L. Chlorine alone as Cl_2 is highly toxic and it is often used as a disinfectant. In combination with a metal such as sodium it becomes essential for life. Small amounts of chlorides are required for normal cell functions in plant and animal life. Criteria for protection of aquatic life require levels of less than 600 mg/L for chronic (long-term) exposure and 1200 mg/L for short-term exposure.

The concentration of chloride is measured by titration by Mohr’s method.

3.3.3 BIOLOGICAL PARAMETERS:

Biological parameters of water are important water quality testing factors. Biological parameters of water indicate the presence of microbiological organisms and pathogens in water. From, health prospective, biological parameters are more important to test for, then physical and chemical parameters. Presence of these micro-organisms in water can cause deterioration of health when consume directly. These organisms that affect the quality status of water generally includes bacteria, protozoa, virus and algae.

3.3.4 DRINKING WATER QUALITY STANDARDS

Table 3.1: Standards for water quality parameters as per BIS (IS- 10500:2012)

Parameter	BIS standards
Fe(mg/l)	0.3
Nitrate NO3(mg/l)	45
F(mg/l)	1.5
p^H	6.5-8.5
Turbidity (NTU)	5
Total alkalinity (mg/l)	200
Total Hardness (mg/l)	300
TDS (mg/l)	500
Calcium	80.1
Magnesium	24.28
Sulphate	400
Chloride	250

CHAPTER-4

MORI KOLONG BEEL, NAGAON- THE STUDY AREA

4.1 INTRODUCTION

The Mori Kolong wetland is one of the largest wetlands of Assam situated in the south bank flood plains of mighty Brahmaputra in Nagaon district. Its location is just 1.5 km from the Nagaon main town in the south direction along the 36 National Highway. It extends from 26º19´N to 26º22´N and 92º40´E to 92º43´ E. Its elevation is 60.6m from the mean sea level. The physiography of the Mori Kolong area is plain with a very gentle slope. Due to various earthquake from 1670 to 1950 the Kolong river changes its course from time to time. As a result of the shifting of the course of the river, this wetland has got origin in the sub urban zone of the Nagaon town.

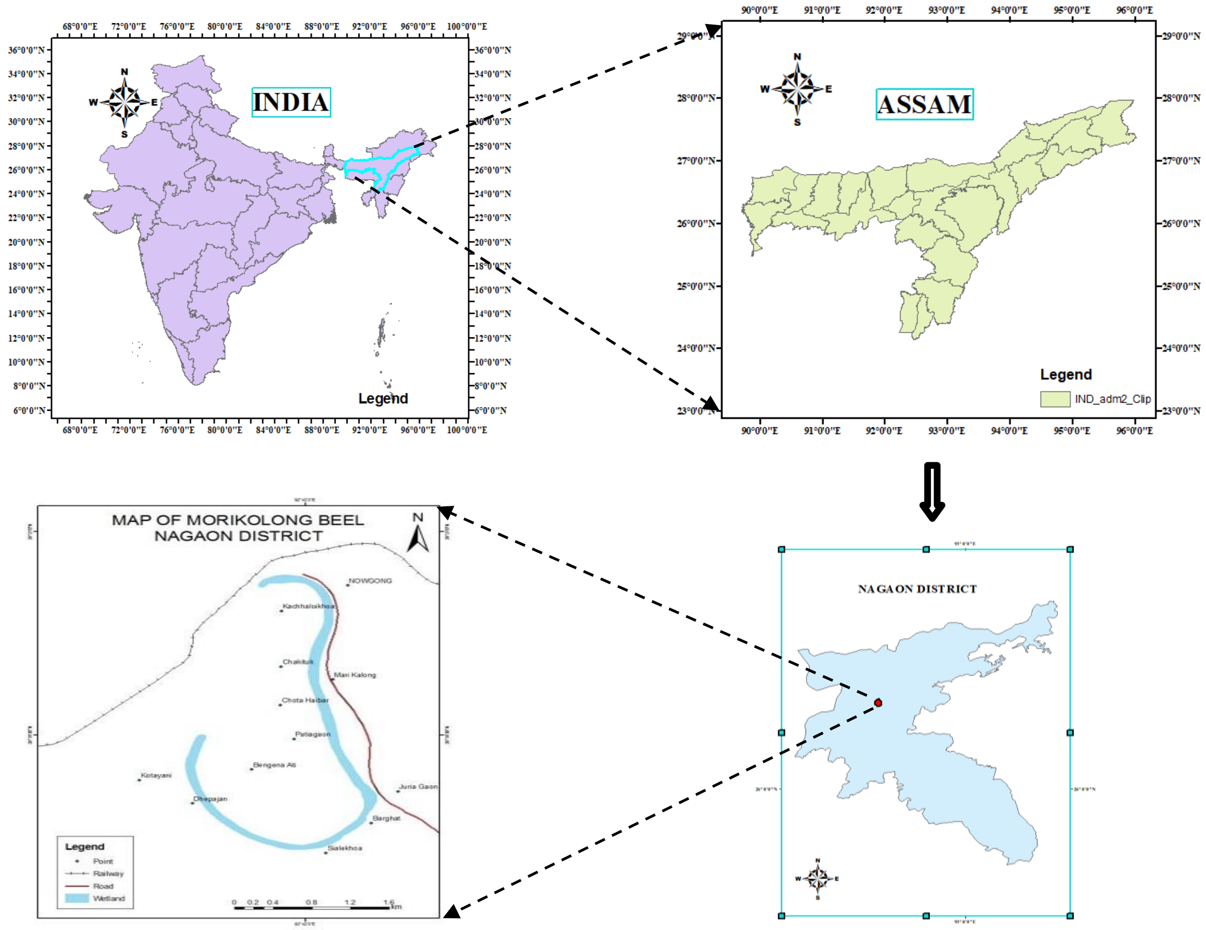


Fig 4.1: Map of Assam showing Mori Kolong Beel

4.2 LOCATION, BOUNDARIES AND PHYSIOGRAPHY

Mori Kolong Beel lies in the central part of the Nagaon District. The Beel is located between latitude: 26º19´N to 26º22´N and longitude 92º40´E to 92º43´ E. Mori Kolong Beel one of the ox-bow lake shaped wetland of Nagaon district. Mori Kolong Beel spread from Nagaon town which includes with urban area and it extends up to1` Mori Kolong Barghat which is basically fall in rural area. Originally Mori Kolong Beel was linked with Puta Kolong and Milanpur fisheries. Mori Kolong Beel were formed by the shifting courses of river Kolong. The total area of Mori Kolong Beel approximately 578099 sq. m in 2014. The NH 36 passes nearby in the eastward side of Mori Kolong Beel. The wetland receives most of the surface runoff from the nearby area, which is one of the reasons of sedimentation of the wetland. Deposited soil in the bed of the wetland is the cause of lowering the depth of the Beel.

4.3 CLIMATE

Mori Kolong Beel, located in Nagaon district, Assam, experiences a humid subtropical climate, characterized by distinct seasonal variations influenced by the region's geographical location in the Brahmaputra River basin. The climatic conditions in this area play a crucial role in the ecological health and hydrological dynamics of the beel.

4.3.1 SEASONS

The climate of Mori Kolong Beel can be broadly divided into three primary seasons:

- **Summer (March to June)**:
  Summers in the region are hot and humid, with temperatures ranging from 25°C to 35°C. Humidity levels often exceed 80%, making the season uncomfortable. Pre-monsoon showers, locally known as "Nor'westers," are common during this time, bringing brief but intense rainfall.
- **Monsoon (June to September)**:

The monsoon season dominates the climate, driven by the southwest monsoon winds. The region receives heavy rainfall, with average annual precipitation ranging from 1,800 mm to 2,200 mm. Rainfall during this period replenishes the beel, leading to increased water levels and influencing aquatic biodiversity.

- **Winter (October to February):**
  Winters are mild and pleasant, with temperatures ranging from 10°C to 25°C. This is the driest period of the year, with minimal rainfall and reduced humidity. The cooler temperatures and stable water levels make this season critical for migratory birds and other wildlife dependent on the Beel.

4.4 RESOURCES OF MORI KOLONG BEEL

Mori Kolong Beel is one of the richest biodiversity areas within the wetland ecosystem of Nagaon District, Assam. Its partially deep water and partially shallow water as well as the presence of high land support large numbers of plant and animal species. Again, the presence of natural forest adjoining the Beel area support large numbers of endangered and threatened vertebrate species. Mori Kolong Beel with its rich ecological system, provides habitat to a large number of bird species. 10 species of birds including 6 migratory species are reported in the Beel area. During winter season, various migratory bird species are seen to be habituating in the Mori Kolong Beel. During the summer, large parts of the Beel are covered by aquatic vegetation like water hyacinth; aquatic grasses, water lilies and others sub merged, emergent and floating vegetation. Moreover, a large number of fishes are also found in this wetland.

4.5 ENVIRONMENTAL PROBLEMS OF MORI KOLONG BEEL

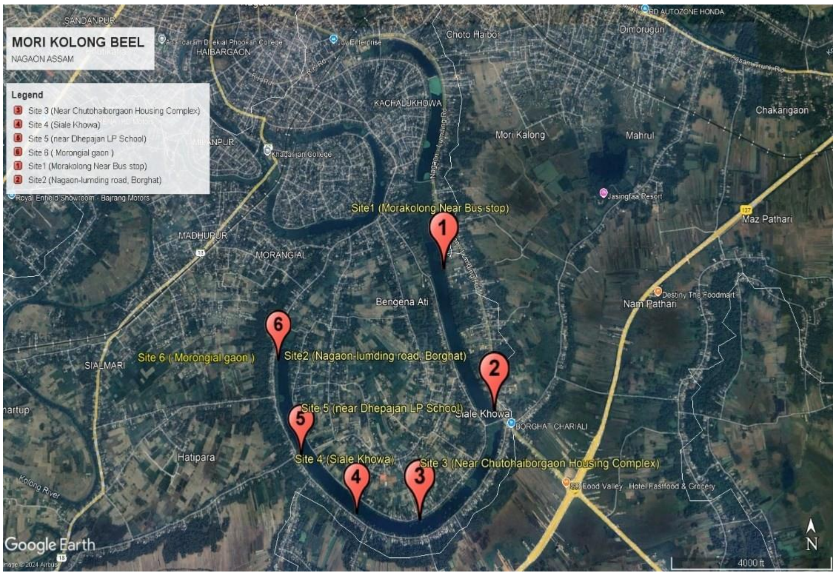
Due to more human intervention some portion of the Beel is disappeared. A bus stand was constructed on the Beel by filling a considerable portion of the Beel. The bus stand has affected the entire ecosystem. Due to the Construction of the bus stop, there has been blockage in water flow system. Due to rapid increase of the resident areas leads to increase the waste products which are often directly dumped into the Beel, which will have a significant impact on the wetland system. Another notable cause for the wide spread deterioration of the quality of water of Mori Kolong Beel, in some portions, pipes and drains of domestic toilets are open into the Beel, which lies in the south eastern corner of Mori Kolong Beel.

CHAPTER-5

METHODOLOGY

5.1 SELECTION OF SITES

Study area Mori Kolong Beel in the Nagaon district, located at just 1.5 km from the Nagaon main town in the south direction along the 36 National Highway Western part of Assam, a North Eastern State in India. The total area of Mori Kolong Beel approximately 578099 sq. m. The lake is located between 26º19´N to 26º22´N and 92º40´E to 92º42´ E.



Site No	Pinpoint Location	Latitude(N) in degree	Longitude(E) in degree
1	Mori Kolong near Bus stop	26°19'42.79"N	92°41'57.40"E
2	Borghat (Nagaon-Lumding road)	26°19'8.35"N	92°42'10.96"E
3	Chuto Haiborgaon housing complex	26°18'43.75"N	92°41'49.51"E
4	Siale Khowa	26°18'45.20"N	92°41'32.08"E
5	Dhepajan LP school	26°18'58.68"N	92°41'16.49"E
6	Morongial Gaon	26°19'20.96"N	92°41'9.71"E

Fig 5.1: GPS location of Sampling sites of Mori Kolong Beel.

5.2 COLLECTION AND PRE-TREATMENT OF SAMPLES

Samples were taken from Mori Kolong Beel in November 2024. Six fixed sampling locations were used consistently throughout the study (Fig. 5.1). The sampling points were initially selected with eye estimation in such a way that they may spread throughout the midrange of the entire surface of the lake. Samples were taken in the first week of November month from a depth of 1 m to ensure a regular sampling pattern. Sampling procedures were performed from 09:00 AM to 11:30 AM for minimizing the influence of fluctuation in water quality throughout the day. Some physico-chemical parameters like Total Dissolved Solids (TDS), Electrical Conductivity (EC), pH and Temperature (T), salinity were estimated with Multiparameter Water Quality Analyzing device. Other parameters like Total Hardness (TH), chloride content (Cl), Nitrate (NO_3), Fluorine (F), Magnesium (Mg), Calcium (Ca) were estimated in laboratory. Samples were collected in 1-L Sample Bottles and kept in ice box immediately after collection. The bottles were brought in the laboratory within 10 h after collection and preserved in refrigerator to estimate the parameters on the next day. In this study World Health Organization (WHO) (BIS, 2012) and Indian Standard 10500: 2012 (IS 10500: 2012) Guidelines (Moharana et al., 2014; WHO, 2008) were followed for the permissible limits of the Water Quality Parameters (WQP).

Fig 5.2: Sample collection from Mori Kolong Beel.

Fig 5.3: Marking of Collected samples from Mori Kolong Beel

5.3 ANALYTICAL METHODS OF TESTING

5.3.1 METHODOLOGY TO DETERMINE ELECTRONIC CONDUCTIVITY

Electrical conductivity (EC) is a measure of the water's ability to conduct electricity, which is directly related to the concentration of dissolved ions (such as salts, acids, and bases) in the water. The EC is an important water quality parameter and can be used to estimate the Total Dissolved Solids (TDS) in water. Measuring the electrical conductivity of water is a quick and reliable method to assess water quality, especially for understanding the concentration of dissolved ions. It is widely used in various fields, including environmental monitoring, industrial processes, and water treatment. Regular calibration and maintenance of the conductivity meter are essential for obtaining accurate and consistent results.

Fig 5.3.1: A conductivity measuring meter

5.3.2 METHODOLOGY TO DETERMINE TOTAL IRON

Iron is one of the most common elements found in groundwater and surface water in India. It is typically present in water in its dissolved form as ferrous ions (Fe^{2+}) or in its oxidized state as ferric ions (Fe^{3+}). The presence of iron in water can have both beneficial and detrimental effects depending on its concentration and the form in which it exists. In India, iron contamination in drinking water is a widespread concern, especially in rural and semi-urban areas. The Indian Standard (IS 10500:2012) sets the permissible limit for iron concentration in drinking water at 0.3 mg/L (milligrams per liter), but many regions across the country exceed this limit.

- In some regions, iron levels in groundwater can reach up to 10–20 mg/L, which is significantly higher than the permissible limit.

Here we determine the iron in sample using Iron Phenanthroline Method (APHA 3500-Fe B)

Procedure:

- Take 50 ml sample in a 125 ml Erlenmeyer flask
- Add 2 ml Conc. Hydrochloric Acid
- Add 1 ml Hydroxylamine Hydrochloride ($NH_20H.HCl$)
- Add few glasses bead and heat to boiling. To ensure dissolution of all the iron, continue boiling until volume is reduced to 15-20 mL
- Cool to room temperature
- Transfer to a 50- or 100-mL volumetric flask
- Add 10 ml Ammonium Acetate ($NH_4C_2H_3O_2$) buffer solution
- Add 4 ml Phenanthroline solution and dilute to mark with distilled water
- Mix thoroughly and allow a minimum of 10 min for maximum colour development

Read Absorbance at 510 nm

Fig 5.3.2: A UV VIS Photo Spectro meter

5.3.3 METHODOLOGY TO DETERMINE NITRATE

Nitrate (NO_3^-) is a chemical compound that naturally occurs in the environment, primarily in soil, water, and plants, as part of the nitrogen cycle. However, when nitrate concentrations in drinking water exceed safe levels, it can pose significant health risks to humans and animals. Nitrate contamination in drinking water is a significant environmental and public health issue, primarily due to agricultural runoff, wastewater discharge, and improper waste management. High levels of nitrates in water pose serious health risks, especially for infants, and can contribute to long-term health issues such as cancer and thyroid dysfunction. It is essential to monitor and regulate nitrate levels in drinking water sources to ensure safe water for communities. Implementing sustainable agricultural practices, improving wastewater treatment, and using effective water treatment technologies are critical steps in mitigating nitrate contamination and protecting public health. Here we have used the Nitrate UV Screening Method to determine the Nitrate in the water sample.

Procedure:

- Pipette 50 ml sample in a dry 100 ml Volumetric flask
- Add 1 ml 1M HCl
- Read Absorbance

Fig 5.3.3: Nitrate measuring Device

5.3.4 METHODOLOGY TO DETERMINE FLUORIDE

Fluoride is a naturally occurring mineral that can be found in soil, water, and various types of rock formations. In water, fluoride typically exists in the form of Fluoride ions (F^-). Fluoride concentrations in water can vary significantly depending on the geographical region, geological conditions, and local sources of contamination. While fluoride is beneficial in small amounts, particularly for dental health, excessive fluoride in drinking water can cause several health issues. In India, fluoride contamination in drinking water has become a major public health concern in several states, especially in rural areas. Fluoride contamination in drinking water is a major public health issue in several parts of India, particularly in rural areas where groundwater is the primary source of water. While fluoride is beneficial for dental health at low concentrations, excessive levels of fluoride in water can lead to serious health problems such as dental and skeletal fluorosis. Addressing this issue requires effective water treatment methods, increased awareness, and the implementation of policies to ensure safe drinking water for the affected populations.

Here, we have used the Fluoride Ionometric Method to determine Fluoride in water samples. (IS 3025 part 60: 2008)

Procedure:

- Calibrate 0.1 ppm, 1 ppm, 10 ppm standard solution in ion meter
- Take 10 ml sample in a flask
- Add 1 mi TISAB III

Record the readings displayed against respective standards.

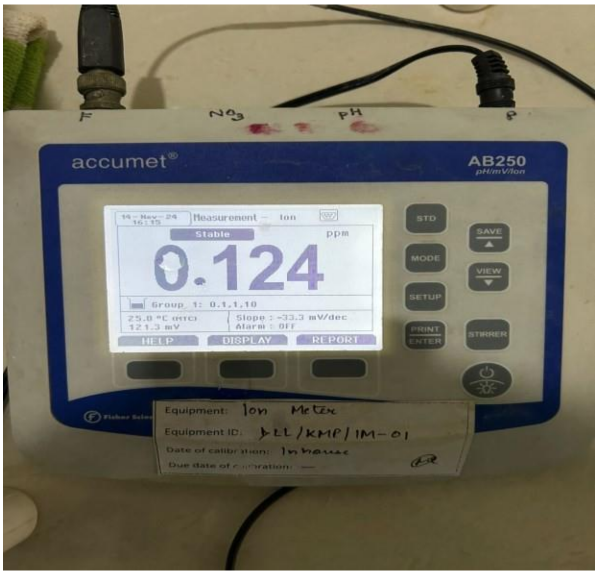


Fig 5.3.4: An ion meter

5.3.5 METHODOLOGY FOR MEASUREMENT OF pH VALUE

The pH of a solution is a measure of its acidity or alkalinity, defined as the negative logarithm of the hydrogen ion concentration ($[H^+]$) in a solution. The pH scale ranges from 0 to 14, with values less than 7 indicating acidic conditions, values greater than 7 indicating alkaline conditions, and a value of 7 representing a neutral solution. Determining the pH of water or any solution is an essential task in water quality analysis, environmental monitoring, and industrial processes.

The pH value is determined by measurement of the electromotive force of a cell consisting of an indicator electrode (an electrode responsive to hydrogen ions such as a glass electrode) immersed in the test solution and a reference electrode (usually mercury/calomel electrode), Contact between the test solution and the reference electrode is usually achieved by means of a liquid junction, which forms part of the reference electrode. The electromotive force is measured with a pH meter, that is, a high impedance voltmeter calibrated in terms of pH. Several types of electrodes have been suggested for electrometric determination of pH value. Although the hydrogen gas electrode is recognized as primary standard the glass: electrode in combination with calomel electrode is generally used with reference potential provided by saturated calomel electrode. The glass electrode system is based on the fact that a change, of 1 pH 13 unit produces an electrical change of 59.1 mV at 25°C. The active element of a glass electrode is a membrane of a special glass. The membrane forms a partition between two liquids of differing hydrogen ion concentration and a potential is produced between the two sides of the membrane which is proportional to the difference in p^H between the liquids.

APPARATUS USED:

1. pH meter with glass and reference electrode (saturated calomel), preferably with temperature compensation.
2. Thermometer With least Count Of 0.5°C.

SAMPLE HANDLING AND PRESERVATION

1. Samples should be analysed as soon as possible, preferably in the field at the time of sampling.
2. High purity water and water not at equilibrium with the atmosphere (ground water or lake water collected at depth) are subject to changes when exposed to the atmosphere, Therefore the sample containers should be filled completely and kept sealed prior to analysis.

PROCEDURE

After required warm-tip period, standardize the instrument with a buffer solution of pH near that of the sample and check electrode against at least one additional buffer of different pH value. Measure the temperature of the water and if temperature compensation is available in the instruments adjust it accordingly. Rinse and gently wipe the electrodes with solution. If field measurements are being made, the electrodes may be immersed directly in the sample stream to an adequate depth and moved in a manner to ensure sufficient sample movement across the electrode sensing element as indicated by drift free readings (< 0.1 pH unit). If necessary, immerse them into the sample beaker or sample stream and stir at a constant rate to provide homogeneity and suspension of solids. Rate of stirring should minimize the air transfer rate at the air-water interface of the sample. Note and record sample pH and temperature However, if there is a continuous drift, take a second reading with the fresh aliquot of sample without stirring and report it as the pH value.

Fig 5.3.5: pH measuring device

5.3.6 METHODOLOGY TO DETERMINE TURBIDITY

Turbidity measurement is crucial for assessing water quality in India, particularly for ensuring safe drinking water and monitoring environmental conditions. The method involves using a turbidimeter to measure the number of suspended particles that scatter light, with results reported in NTU. The process is standardized and ensures that water treatment processes are functioning effectively and are in line with national and international water quality standards. The procedure for determining the turbidity of water typically involves using a turbidimeter or nephelometer to measure the scattering of light caused by suspended particles in the water. It is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. Turbidity measurement is crucial for assessing water quality in India, particularly for ensuring safe drinking water and monitoring environmental conditions. The method involves using a turbidimeter to measure the number of suspended particles that scatter light, with results reported in NTU. The process is standardized and ensures that water treatment processes are functioning effectively and are in line with national and international water quality standards.

5.3.7 METHODOLOGY TO DETERMINE TOTAL ALKALINITY INDICATOR METHOD (IS 3025 PART 23)

Total alkalinity (TA) refers to the capacity of water to neutralize acids. It is an important parameter in water chemistry, especially in pools, aquariums, and natural water systems. Alkalinity is primarily contributed by bicarbonates, carbonates, and hydroxides, which act as buffers to stabilize pH levels. A proper level of alkalinity helps maintain a stable pH, preventing sharp changes that could harm aquatic life, cause corrosion, or affect the effectiveness of chemicals used in water treatment.

PROCEDURE

- Take 50 ml sample in a 100 ml conical flask.
- If the pH of the sample is over 8.3 then add 2 to 3 drops of phenolphthalein indicator and titrate with standard 0.02 N Sulphuric acid (H_2S0_4) solution till the pink colour observed by indicator just disappears.
- Record the volume of 0.02 N standard Sulphuric acid solution from the burette.

- If p^H of the sample is below 8.3 then eliminating the step 2 and 3, Add 2-3 drops of mixed indicator (Bromocresol Green-Methyl Red indicator) solution. The colour of sample changes to Blue.
- Titrate with 0.02 N Sulphuric Acid solution (Colour changes from Blue to Pink)

Calculation:

Total alkalinity (as $CaCO_3$), in mg/L = (A X N X 5000) / V

Where,

A = ml of standard Sulphuric acid used to titrate to pH 83,

N = normality of Standard acid used, and

V = volume in ml of sample taken for test.

5.3.8 METHODOLOGY TO DETERMINE TOTAL HARDNESS

Total hardness refers to the concentration of dissolved minerals in water, primarily calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions, which are responsible for the water's hardness. The hardness of water is typically measured in terms of calcium carbonate ($CaCO_3$) equivalents. Hard water is characterized by a higher concentration of these minerals, and its presence can have both beneficial and adverse effects on water systems, appliances, and health. Total hardness is commonly measured in terms of milligrams per liter (mg/L) or parts per million (ppm) of calcium carbonate ($CaCO_3$). The hardness level can be determined by Titration method, where the water sample is titrated with a standard solution of a known concentration, often using a reagent like EDTA (ethylenediaminetetraacetic acid) that binds with calcium and magnesium ions to determine their concentration.

Procedure:

- Take 25 ml sample in a 250 ml conical flask.
- Add 1 ml Hydroxylamine hydrochloride solution.
- Adjust the pH in between 10-10.1 by adding 1-2 ml Buffer Solution.
- Add 1/2 drops of EBT (Eriochrome Black T) indicator (Colour changes to wine red)
- Titrate with 0.02N EDTA solution (Colour changes from wine red to
- Note down the end point from the burette
- Blank titration is carried out in a similar way

Calculation

$$\text{Total Hardness} = [\,1000 \times (V_1 - V_2) \times CF\,] / V_3$$

Where,

V_1= Volume of EDTA std solution used in the titration for sample

V_2= Volume of EDTA std solution used in the titration for the blank sample

V_3 = Volume of the sample taken for the test

X_1 = Volume of std Calcium solution taken for standardization

X_2 = Volume of EDTA solution used in the titration

Correction Factor (CF) = X_1/X_2

5.3.9 METHODOLOGY TO DETERMINE TOTAL DISSOLVED SOLIDS (TDS)

Total Dissolved Solids (TDS) refers to the combined content of all inorganic and organic substances dissolved in water. These substances include minerals, salts, metals, cations, and anions that are present in the water in a dissolved state. TDS is often measured in milligrams per liter (mg/L) or parts per million (ppm). High TDS levels can indicate pollution or contamination, while low levels might suggest very pure or distilled water. Here, TDS have been found using 'Thermo scientific' TDS meter. A TDS meter is an electronic device that measures the electrical conductivity of water and directly provides a TDS reading in ppm or mg/L. It is an efficient and widely used method for quick on-site measurements.

Fig 5.3.9: A TDS measuring device

5.3.10 METHODOLOGY TO DETERMINE SULPHATE

Sulphate is a naturally occurring compound, primarily found in water as sulphate ions (SO_4^{2-}), which come from various sources such as natural mineral deposits, industrial discharge, and agricultural activities. In water, sulphates can be dissolved as salts, most commonly as calcium sulphate (gypsum) or sodium sulphate. Sulphates are not usually harmful in low concentrations but can impact water quality and taste when present in higher amounts. In India, the presence of sulphate in water is of particular concern, especially in regions with high industrial activity or mining operations. In India, sulphate contamination in water is a growing concern, especially in regions with high industrial, agricultural, or mining activities. While sulphates at low concentrations are generally not harmful, high levels can affect the taste of water and pose health risks, particularly for infants and individuals with sensitive digestive systems. Monitoring and managing sulphate levels through water treatment and regulation are essential to maintaining safe water quality standards across the country. Here, we have used UV-VIS Spectrophotometer for finding Sulphate.

Procedure: SULPHATE TURBIDITY METHOD (IS 3025 PART 24)-1986, Reaffirmed 1992

- Filter the sample through 0.45 µm, membrane filter, if there is any turbidity.

- Take 20 ml sample in a 100 ml conical flask
- Add 1 ml Hydrochloric acid solution and 1 ml conditioning reagent and mix well for 30 sec.
- Add a spoonful or 3 gm of $BaCl_2$ (Barium Chloride) crystals and stir at constant speed for 1 min.
- Read Absorbance at 420 nm.

5.3.11 METHODOLOGY TO DETERMINE CHLORIDE

Chloride can be titrated with mercuric nitrate because of the formation of soluble, slightly dissociated mercuric chloride. In the pH range 2.3 to 2.8. diphenyl carbazone indicates the end point by the formation of a purple complex with excess mercuric ions. Use a 100 ml sample that the chloride content is less than 10 mg. Add 1.0 ml indicator acidifier reagent. For highly alkaline or acid waters, adjust pH to about 8 before adding indicator-acidifier reagent. Titrate with 0.41 1 N mercuric nitrate to a definite purple end point. The solution turns from green blue to blue a few drops before the end point. Determine the blank by titrating 100 ml distilled water containing IO mg of sodium bicarbonate.

Calculation:

Chloride, mg/L = $[(V_1-V_2) X N X35450]/V_3$

Where,

V_1= volume in ml of silver nitrate used by the sample,

V_2 = volume in ml of silver nitrate used in the blank titration,

V_3 = volume in ml of sample taken for titration and

N = Normality of silver nitrate solution.

5.3.12 METHODOLOGY TO DETERMINE CALCIUM HARDNESS AND CALCIUM ION

Calcium hardness refers to the amount of calcium dissolved in water, which is primarily due to the presence of calcium salts like calcium bicarbonate ($Ca(HCO_3)_2$) and calcium sulphate ($CaSO_4$). When these salts dissolve in water, they release calcium ions into the water, increasing its hardness. The calcium ion (Ca^{2+}) is a positively charged ion (cation) of calcium. Calcium is an essential element found in many natural minerals and is a major contributor to water hardness. It is commonly derived from the dissolution of calcium-based minerals like limestone, gypsum, and dolomite, or from agricultural and industrial activities. In water, calcium ions exist in dissolved form (Ca^{2+}) and can combine with other ions, especially carbonate ions (CO_3^{2-}), to form insoluble compounds such as calcium carbonate ($CaCO_3$), contributing to water hardness. Here we have determined calcium harness and calcium ion using Calcium EDTA Titration Method (IS 3025 part 40).

Procedure:

- Take 25 ml sample in a 250 ml conical flask
- Adjust the pH in between 12-13 by adding 1N NaOH solution drop wise
- Add Murexide indicator 1 pinch (Colour changes to Pink)
- Add Sodium Chloride 2 pinch
- Titrate with 0.01M EDTA solution (Colour changes from pink to purple)
- Note down the end point from the burette

Calculation:
Calcium (Ca^{2+}), mg/L = $(A\times CF\times 1000\times 0.4008)/V$
Calcium Hardness ($CaCO_3$), mg/L = $[A\times CF\times 1000]/V$

Where,
A= Volume in ml of EDTA std solution used for titration
CF= Mass in mg of calcium equivalent to 1 ml of EDTA solution (X1/X2 Correction factor for standardize ion of EDTA)
X_l = Volume in ml of std calcium solution taken for standardization
X_2= Volume of ml of EDTA solution used in the titration
V = Volume in ml of the sample taken for the test.

5.3.12 METHODOLOGY TO DETERMINE MAGNESIUM HARDNESS AND MAGNESIUM ION

A Water sample containing Calcium as CaC03 is estimated and Total Hardness is the sum of $CaC0_3$ and $MgC0_3$. Magnesium hardness is determined by subtracting Calcium hardness from total hardness.

Procedure:

- Calculate the Total hardness as follows: Determine Total Hardness (as CaC03 mg/L) as discussed previously at pH 10 using Eriochrome Black T indicator.
- Calculate the Calcium Hardness as follows: Determine Calcium Hardness (as CaC03 mg/L) as discussed previously at pH 12 — 14 by using murexide indicator.

Calculation:

Magnesium hardness = Total hardness - Calcium hardness (mg/L)

Magnesium (as Mg^{2+}) = Magnesium hardness x 0.243 (mg/L).

CHAPTER – 6

WATER QUALITY ANALYSIS

6.1 RESULT

The different water quality parameters were tested as per the methodology that were described in the previous chapter. Testing of the water quality parameters were done for autumn season- i.e., November 2024.The results obtained in this testing have been presented in both tabular and graphical form in this chapter. The variation in the parameters in different location has been noted and discussed in details. With the results obtained from the test, the water quality status of the study area will be known.

6.1.1 TABULAR OUTPUT OF RESULTS

The different parameters that were analyzed along with their results for the specified months are presented in a tabular form below:

Table 6.1: Concentrations of Water Quality Parameters of the different sampling sites

Water parameter/Sample No	BIS standard	1	2	3	4	5	6
Electronic Conductivity	500µScm^{-1}	362	444	366	300	466	497
Iron, Fe	0.3 mg/l	0.3	0.53	0.47	0.5	0.48	0.45
Nitrate NO_3	45 mg/l	4.549	2.447	4.747	3.631	4.852	5.5
Fluoride F	1.5 mg/l	0.17	0.082	0.124	0.145	0.173	0.134
p^H	6.5-8.5	7.37	7.26	7.31	7.22	7.54	7.45
Turbidity	5 NTU	1.3	10.4	5.8	2.7	3.3	5
Total alkalinity	200 mg/l	30	42	32	30	35	31
Total Hardness	300 mg/l	168	214.2	163.8	160.8	158.3	135
TDS	500 mg/l	240	260	220	255	243	246
Calcium Hardness	80.1 mg/l	84	71.4	84	92.4	77.7	63
Calcium, Ca^{2+}	200 mg/l	33.66	28.61	33.66	31.5	31.5	32.16
Magnesium Hardness	24.28 mg/l	37.91	45.83	33.05	39.51	40.17	44.47
Magnesium, Mg^{2+}	150 mg/l	9.21	11.14	8.03	9.60	9.76	10.81
Sulphate SO_4	400 mg/l	4.064	29.378	6.569	5.164	4.015	6.896
Chloride, Cl	1000 mg/l	43	65	61	52.00	35	40

The above table is a demonstration of the concentration of the 13 different water parameters for the 6 different sampling locations. The values listed are based on laboratory analysis of the water samples from different sampling sites.

6.1.2 GRAPHICAL OUTPUT OF RESULTS:

The results obtained from the testing of water quality parameters are presented in graphical form below:

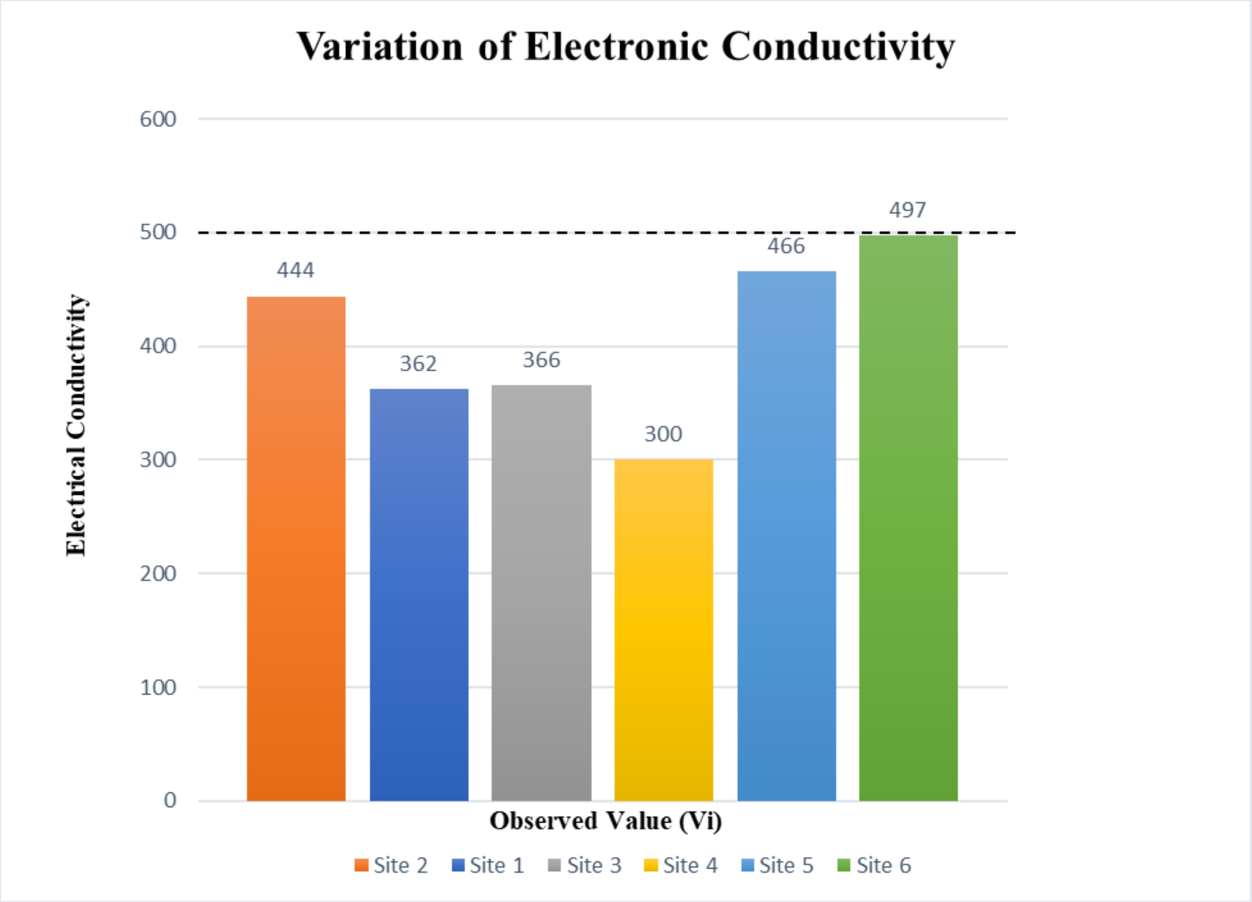


Fig 6.1: Frequency distribution of Electrical Conductivity (EC) variation in different sampling sites.

Fig 6.1 shows the highest value of Electrical Conductivity (EC) at site 6 and the lowest value of Electrical Conductivity (EC) at site 4.

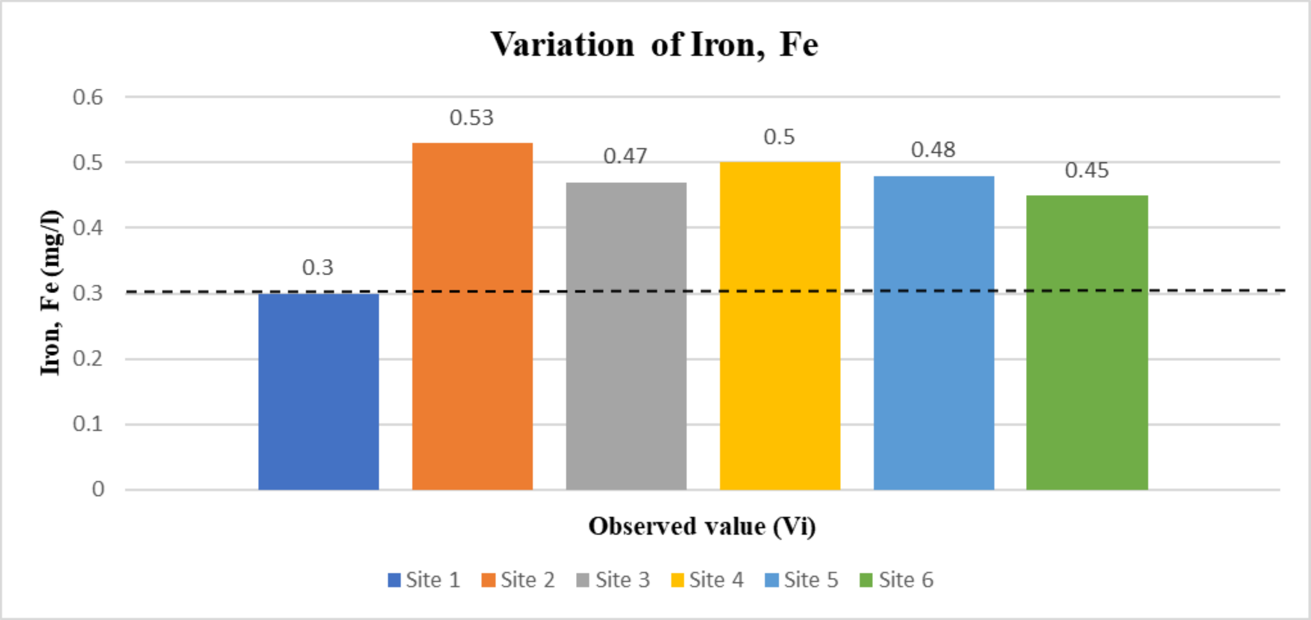


Fig 6.2: Frequency distribution of the pH concentration in the sampling sites

The fig. 6.2 shows the highest value of Iron, Fe at site 2 and the lowest value of Iron, Fe at site 1.

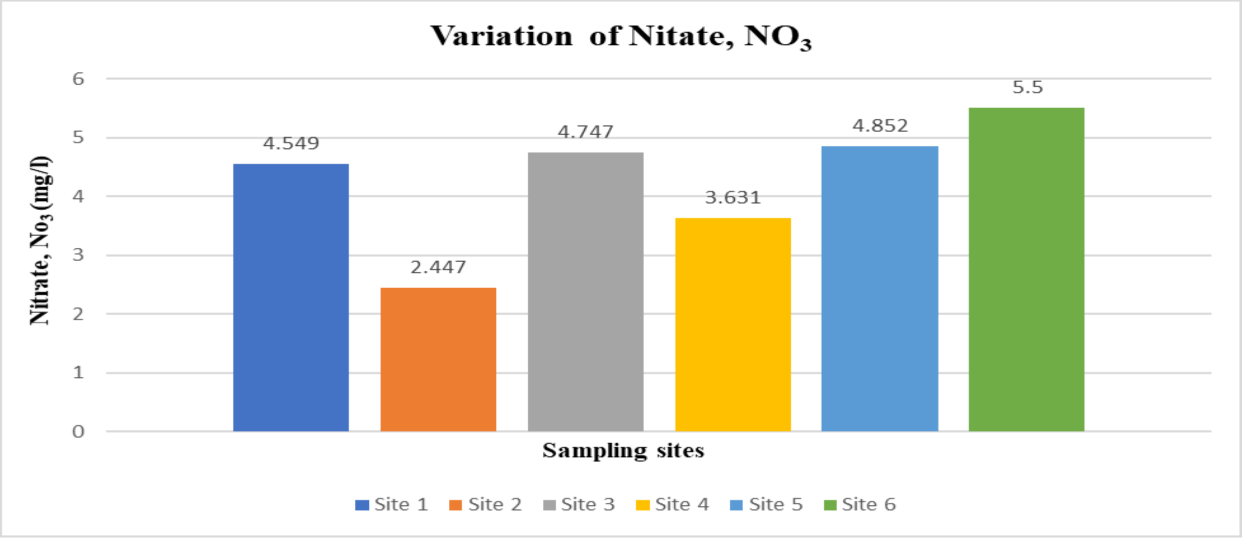


Fig 6.3: Frequency distribution of the Nitrate, NO_3 concentration in the sampling sites

The fig. 6.3 shows the highest value of Nitrate, NO_3 at site 6 and the lowest value of Nitrate, NO_3 at site 2.

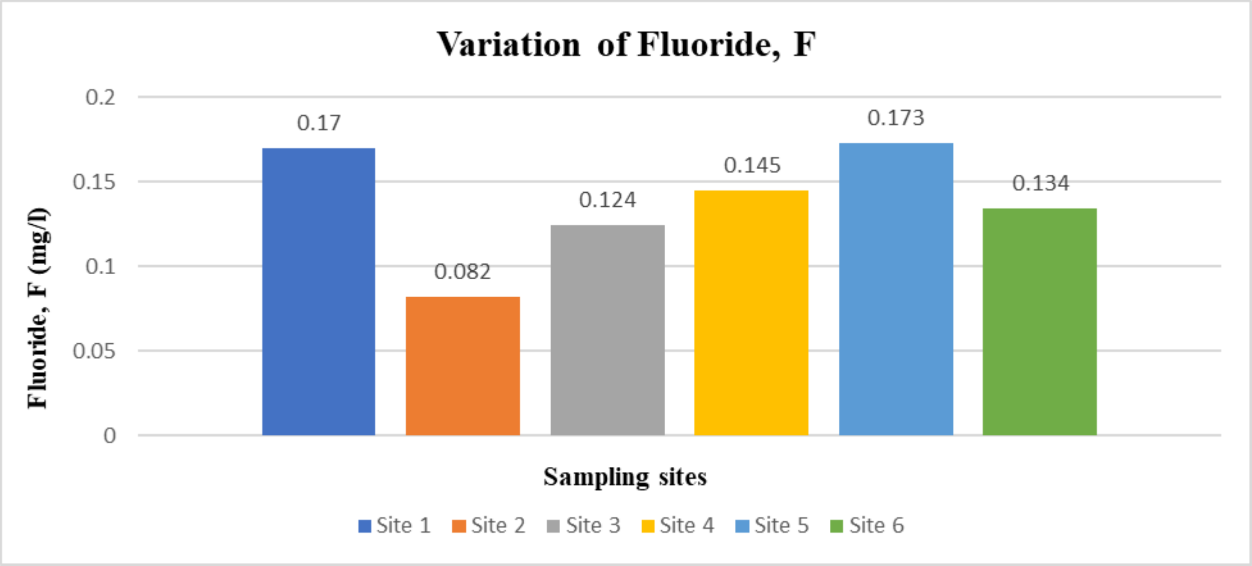


Fig 6.4: Frequency distribution of the Fluoride, F concentration in the sampling sites

Fig. 6.4 shows the highest value of Fluoride, F at site 5 and the lowest value of Fluoride at site 2.

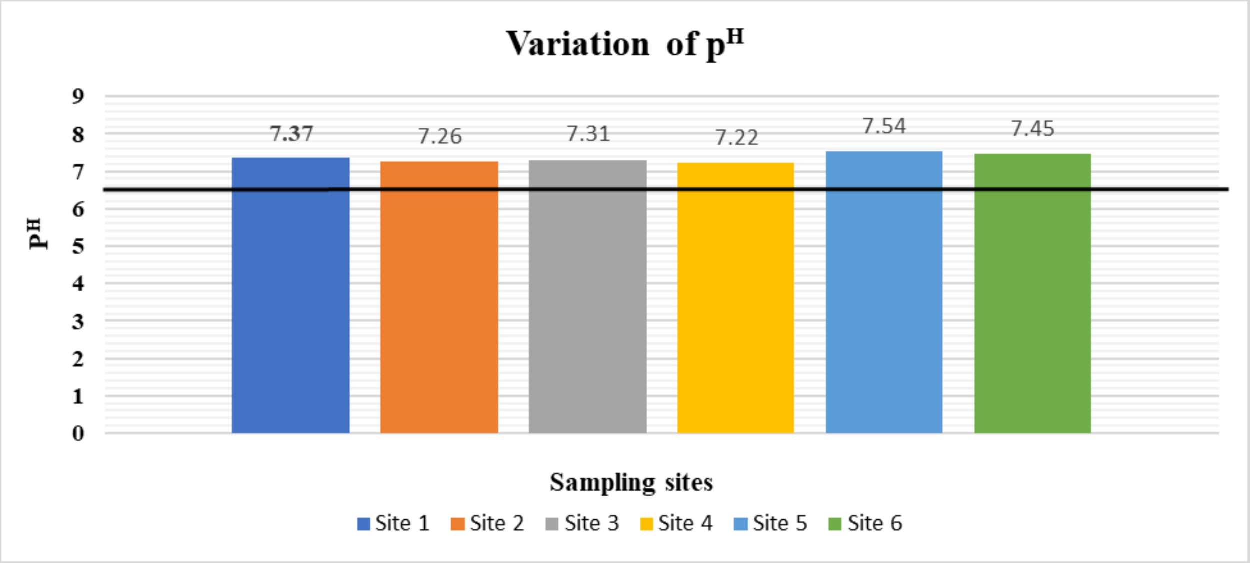


Fig 6.5: Frequency distribution of the p^H concentration in the sampling sites

Fig. 6.5 shows the highest value of p^H at site 5 and the lowest value of p^H at site 4.

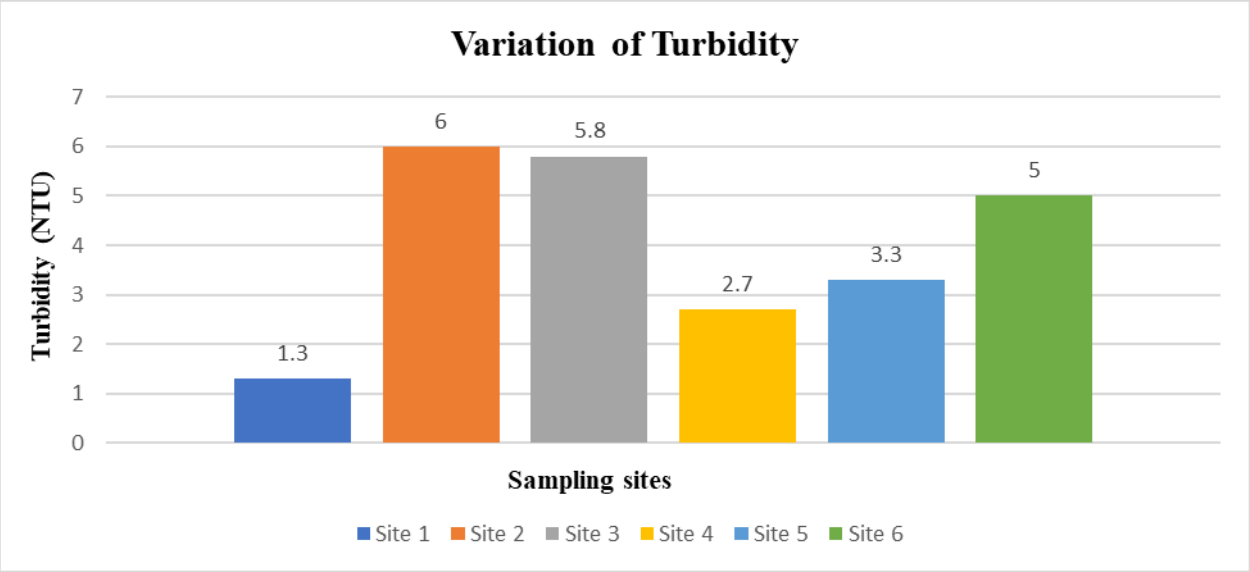


Fig 6.6: Frequency distribution of the Turbidity concentration in the sampling sites

Fig. 6.6 shows the highest value of Turbidity at site 2 and the lowest value of Turbidity at site 1.

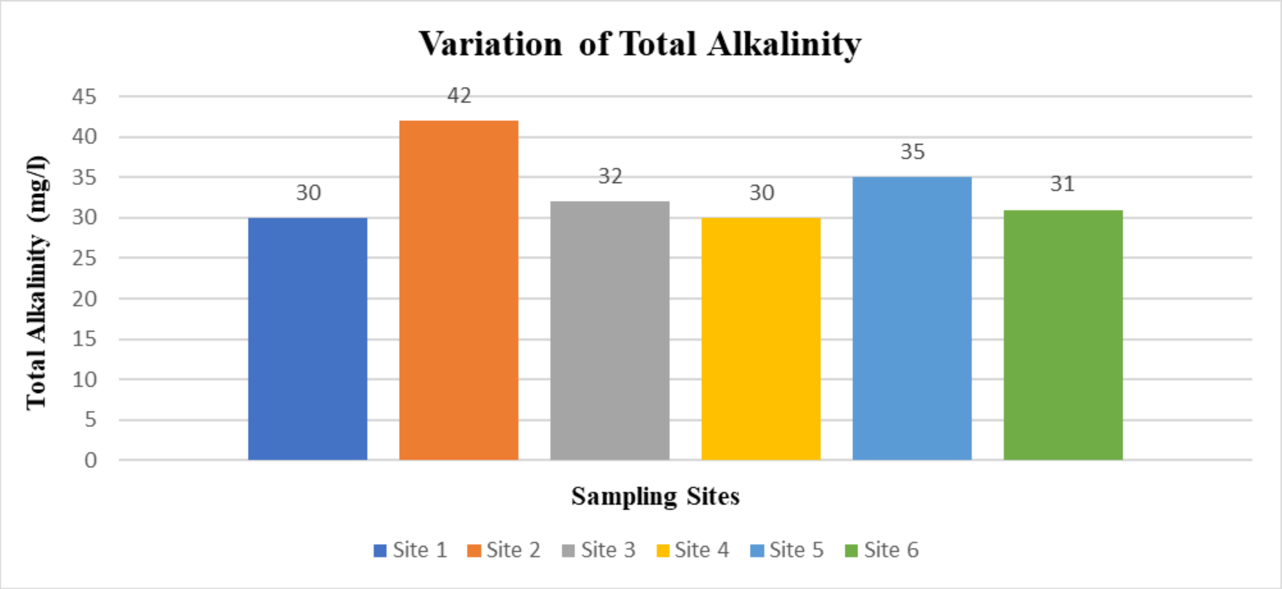


Fig 6.7: Frequency distribution of the Total Alkalinity concentration in the sampling sites

Fig. 6.7 shows the highest value of Total Alkalinity at site 2 and the lowest value of Total Alkalinity at site 1 and site 4.

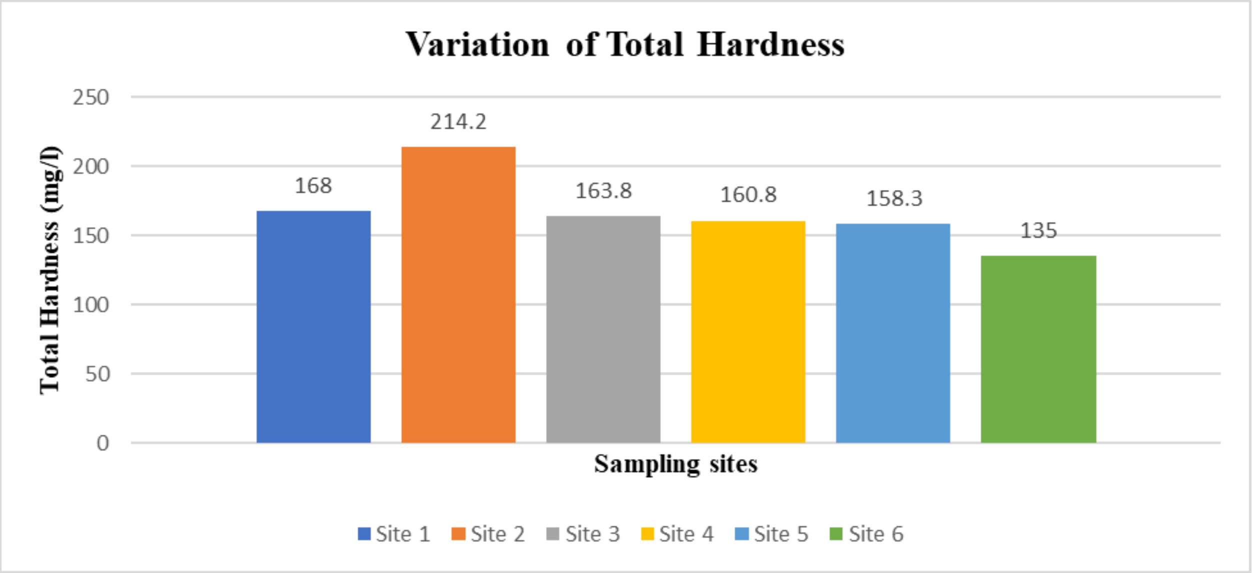


Fig 6.8: Frequency distribution of the Total Hardness concentration in the sampling sites

Fig. 6.8 shows the highest value of Total Hardness at site 2 and the lowest value of Total Hardness at site 6.

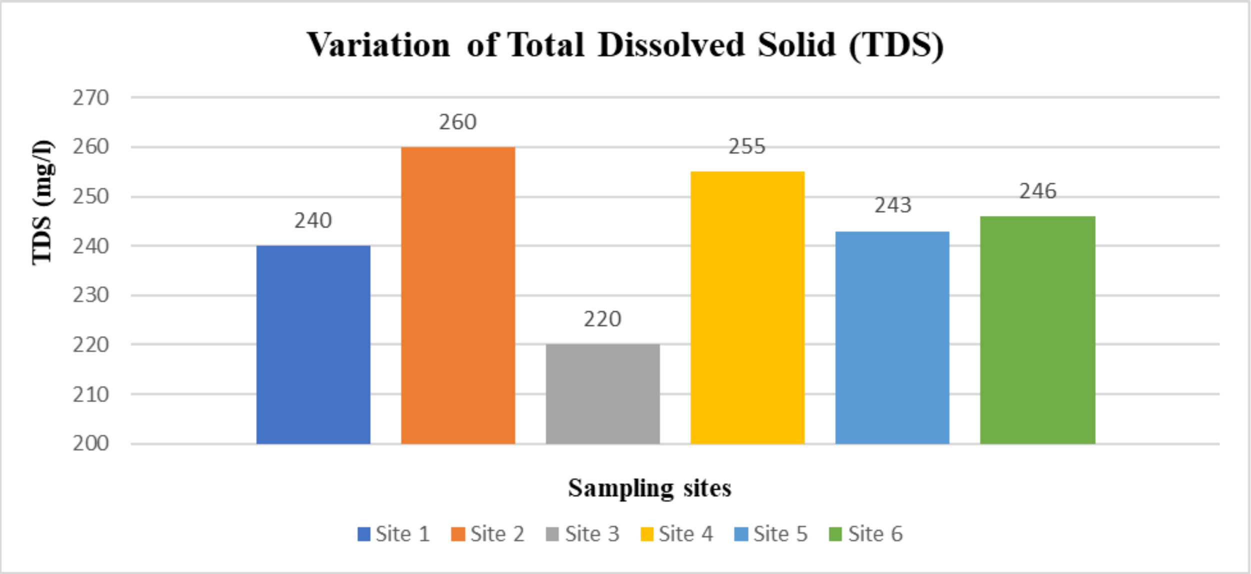


Fig 6.9: Frequency distribution of the TDS concentration in the sampling sites

Fig. 6.9 shows the highest value of TDS at site 2 and the lowest value of TDS at site 3.

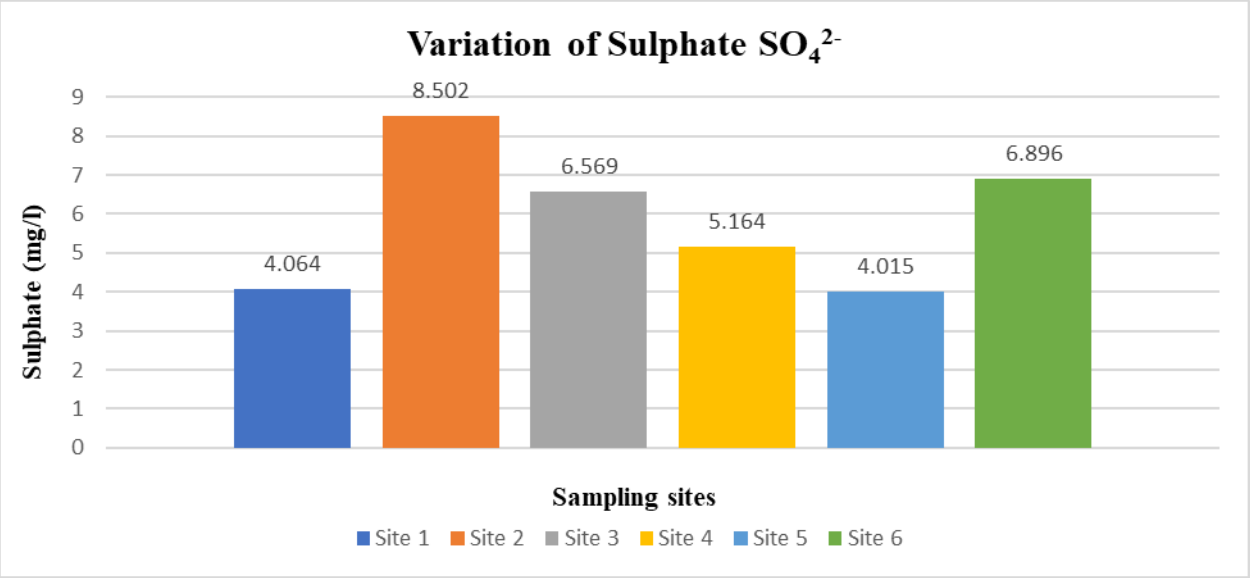


Fig 6.10: Frequency distribution of the Sulphate SO_4^{2-} concentration in the sampling sites

Fig. 6.10 shows the highest value of Sulphate SO_4^{2-} at site 2 and the lowest value of Sulphate SO_4^{2-} at site 3.

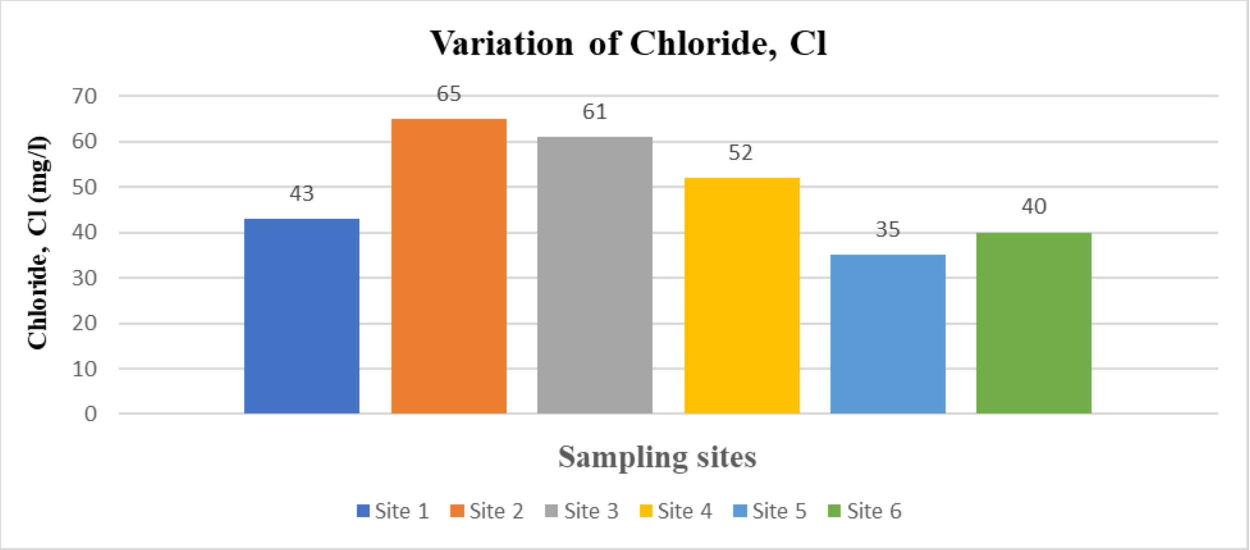


Fig 6.11: Frequency distribution of the Chloride, Cl concentration in the sampling sites

Fig. 6.11 shows the highest value of Chloride, Cl at site 2 and the lowest value of Chloride, Cl at site 5.

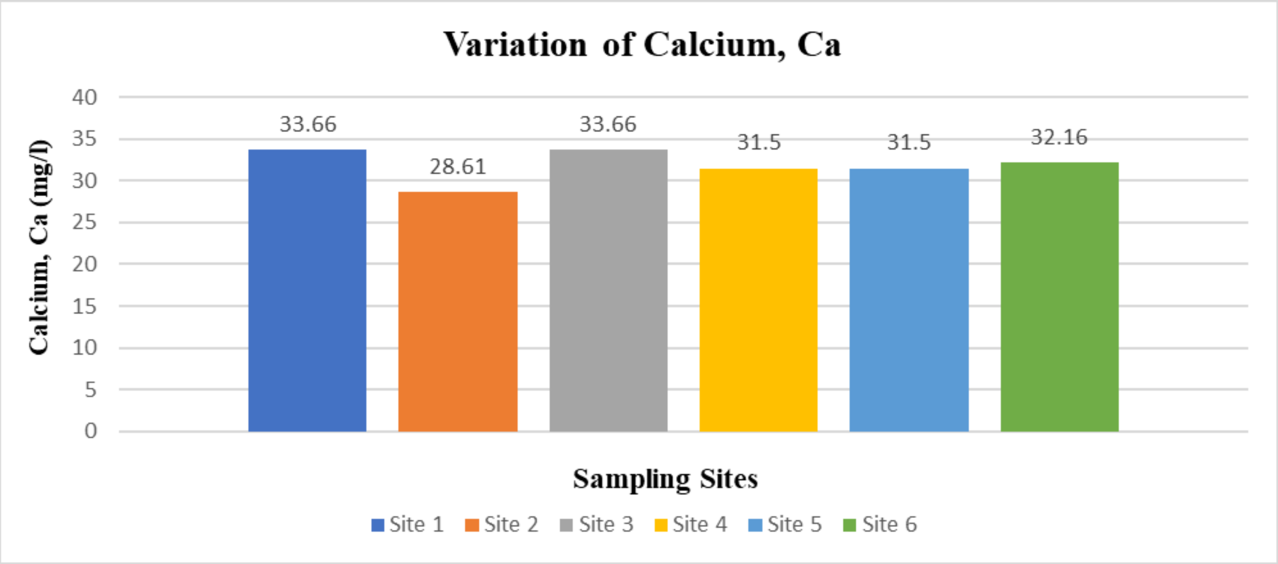


Fig 6.12: Frequency distribution of the Calcium, Ca concentration in the sampling sites

Fig. 6.12 shows the highest value of Calcium, Ca at site 1 and 3 and the lowest value of Calcium, Ca at site 2.

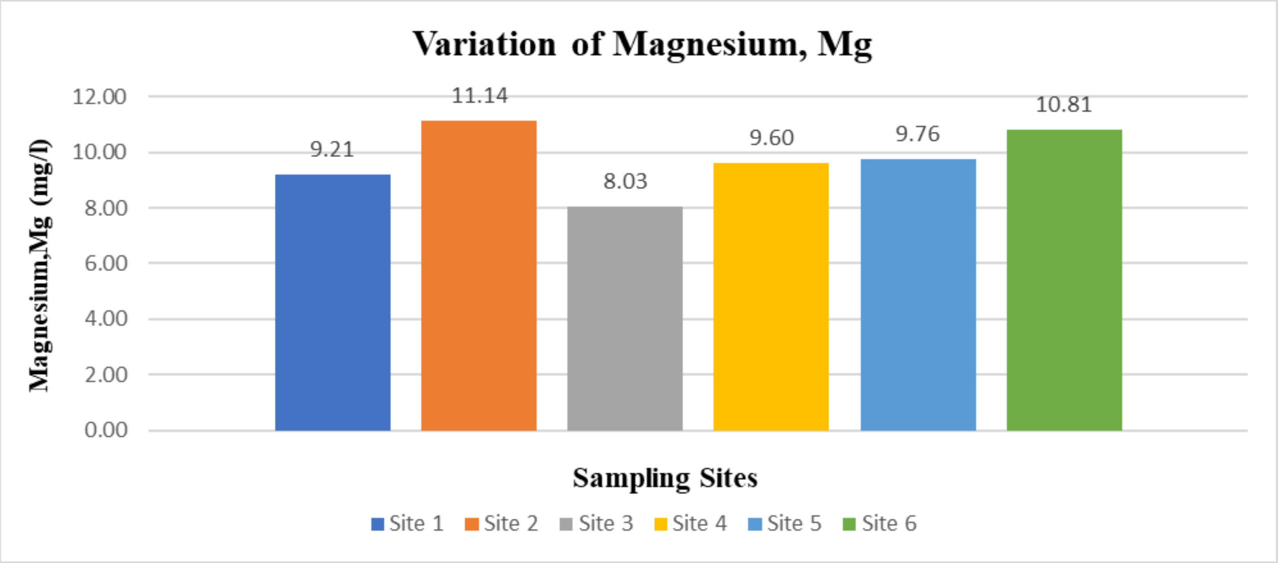


Fig 6.13: Frequency distribution of the Magnesium, Mg concentration in the sampling sites

Fig. 6.13 shows the highest value of Magnesium, Mg at site 2 and the lowest value of Magnesium, Mg at site 3.

CHAPTER – 7

WATER QUALITY INDEX

7.1 WATER QUALITY INDEX

Water quality index indicates single number like a grade that express overall water quality index at certain area and time. It gives general idea of the possible problem with water in a particular region to public.

7.2 CALCULATION OF WQI BY WEIGHTED ARITHMETIC WATER QUALITY INDEX METHOD

Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables. The method has been widely used by the various scientists and the calculation of WQI was made by using the following equation:

$$WQI = \sum Q_n W_n / \sum W_n$$

The quality rating scale (Qi) for each parameter is calculated by using this expression:

$$Q_n = 100[(V_n - V_o)/(S_n - V_o)]$$

Where,

V_n is estimated concentration of nth parameter in the analyzed water.

V_o is the ideal value of this parameter in pure water $V_o = 0$ (except pH =7.0 and DO = 14.6 mg/l)

S_n is recommended standard value of nth parameter

The unit weight (W_n) for each water quality parameter is calculated by using the following formula:

$$W_n = K / S_n$$

Where, K = proportionality constant and can also be calculated by using the following equation:

$K = 1/\sum(1/S_n)$

The rating of water quality according to this WQI is given in Table 7.1.

Table 7.1: Water Quality Rating as per Weighted Arithmetic Water Quality Index Method (Brown et al. 1972)

WQI	*RATING OF WATER QUALITY*
0-25	Excellent
25-50	Good
51-75	Poor
76-100	Very poor
>100	Unsuitable for drinking purposes

Table 7.2: BIS Standards for Various Water Quality Parameters for Drinking Purpose

PARAMETERS	*BIS/IS:2296 STD (Sn)*
EC	500
Iron (mg/l)	0.3
Nitrate (mg/l)	45
Fluoride (mg/l)	1.5
p^H	8.5
Turbidity (NTU)	5
Total Alkalinity (mg/l)	200
Total Hardness (mg/l)	300
TDS (mg/l)	500
Calcium content (mg/l)	200
Magnesium content (mg/l)	150
Sulphate (mg/l)	400
Chloride (mg/l)	1000

Table 7.3: Calculation of Water Quality Index for sampling site 1

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wn=K/Sn	Ideal value (Vo)	Mean concentration value (Vn)	Vn/Sn	Qn=Vn/Sn*100	WnQn
Electronic Conductivity (µScm-1)	500	0.002	4.53404	0.220554	0.000441	0	362	0.724	72.4	0.032
Iron, Fe (mg/l)	0.3	3.33333	4.53404	0.220554	0.73518	0	0.3	1.0000	100	76.324
Nitrate NO_3 (mg/l)	45	0.02222	4.53404	0.220554	0.004901	0	4.549	0.1011	10.109	0.050
Fluoride F (mg/l)	1.5	0.66667	4.53404	0.220554	0.147036	0	0.17	0.1133	11.333	1.666
p^H	8.5	0.11765	4.53404	0.220554	0.025948	7	7.37	0.8671	86.706	2.250
Turbidity	5	0.2	4.53404	0.220554	0.044111	0	1.3	0.26	26	1.147
Total alkalinity (mg/l)	200	0.005	4.53404	0.220554	0.001103	0	30	0.15	15	0.017
Total Hardness (mg/l)	300	0.00333	4.53404	0.220554	0.000735	0	168	0.56	56	0.041
TDS (mg/l)	500	0.002	4.53404	0.220554	0.000441	0	240	0.48	48	0.021
Calcium, Ca^{2+} (mg/l)	200	0.005	4.53404	0.220554	0.001103	0	33.66	0.168	16.83	0.019
Magnesium, Mg^{2+} (mg/l)	150	0.00667	4.53404	0.220554	0.00147	0	8.18	0.055	5.45292	0.008
Sulphate SO_4 (mg/l)	400	0.0025	4.53404	0.220554	0.000551	0	4.064	0.010	1.016	0.001
Chloride, Cl (mg/l)	1000	0.001	4.53404	0.220554	0.000221	0	43	0.043	4.3	0.001
		4.53404			**1.00000**					**81.777**

Table 7.4: Calculation of Water Quality Index for sampling site 2

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wi=K/Sn	Ideal value (Vo)	Mean concentration value(Vn)	Vn/Sn	Qn=Vn/Sn*100	WnSn
Electronic Conductivity (µScm-1)	500	0.002	4.5340	0.220554052	0.000441	0	444	0.888	88.8	0.03917
Iron, Fe (mg/l)	0.3	3.333333	4.5340	0.220554052	0.73518	0	0.53	1.766667	176.7	129.8818
Nitrate NO_3 (mg/l)	45	0.022222	4.5340	0.220554052	0.004901	0	0.447	0.009933	1.0	0.004869
Fluoride F (mg/l)	1.5	0.666667	4.5340	0.220554052	0.147036	0	0.082	0.054667	5.5	0.803797
p^H	8.5	0.117647	4.5340	0.220554052	0.025948	7	7.26	0.854118	85.4	2.216225
Turbidity	5	0.2	4.5340	0.220554052	0.044111	0	10.4	2.08	208.0	9.175049
Total alkalinity (mg/l)	200	0.005	4.5340	0.220554052	0.001103	0	42	0.21	21.0	0.023158
Total Hardness (mg/l)	300	0.003333	4.5340	0.220554052	0.000735	0	214.2	0.714	71.4	0.052492
TDS (mg/l)	500	0.002	4.5340	0.220554052	0.000441	0	260	0.52	52.0	0.022938
Calcium,Ca^{2+} (mg/l)	200	0.005	4.5340	0.220554052	0.001103	0	28.61	0.14305	14.3	0.015775
Magnesium, Mg^{2+} (mg/l)	150	0.006667	4.5340	0.220554052	0.00147	0	11.14	0.074244	7.4	0.010917
Sulphate SO_4 (mg/l)	400	0.0025	4.5340	0.220554052	0.000551	0	29.378	0.073445	7.3	0.00405
Chloride, Cl (mg/l)	1000	0.001	4.5340	0.220554052	0.000221	0	65	0.065	6.5	0.001434
		4.3674			**1.0**					**142.2517**

Table 7.5: Calculation of Water Quality Index for Sampling Site 3

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wn=K/Sn	Ideal value (Vo)	Mean concentration value (Vn)	Vn/Sn	Qn=Vn/Sn*100	WnQn
Electronic Conductivity (µScm-1)	500	0.002	4.53404	0.220554052	0.000441	0	366	0.732	73.2	0.032289
Iron, Fe (mg/l)	0.3	3.333333	4.53404	0.220554052	0.73518	0	0.47	1.566667	156.6666667	115.1782
Nitrate NO_3 (mg/l)	45	0.022222	4.53404	0.220554052	0.004901	0	4.747	0.105489	10.54888889	0.051702
Fluoride F (mg/l)	1.5	0.666667	4.53404	0.220554052	0.147036	0	0.124	0.082667	8.266666667	1.215498
p^H	8.5	0.117647	4.53404	0.220554052	0.025948	7	7.31	0.86	86	2.231488
Turbidity	5	0.2	4.53404	0.220554052	0.044111	0	5.8	1.16	116	5.116854
Total alkalinity (mg/l)	200	0.005	4.53404	0.220554052	0.001103	0	32	0.16	16	0.017644
Total Hardness (mg/l)	300	0.003333	4.53404	0.220554052	0.000735	0	163.8	0.546	54.6	0.040141
TDS (mg/l)	500	0.002	4.53404	0.220554052	0.000441	0	220	0.44	44	0.019409
Calcium, Ca^{2+} (mg/l)	200	0.005	4.53404	0.220554052	0.001103	0	33.66	0.1683	16.83	0.01856
Magnesium, Mg^{2+} (mg/l)	150	0.006667	4.53404	0.220554052	0.00147	0	8.03	0.053538	5.353776	0.007872
Sulphate SO_4 (mg/l)	400	0.0025	4.53404	0.220554052	0.000551	0	6.569	0.016423	1.64225	0.000906
Chloride, Cl (mg/l)	1000	0.001	4.53404	0.220554052	0.000221	0	61	0.061	6.1	0.001345
		4.53404			**1.0000**					**129.1701**

Table 7.6: Calculation of Water Quality Index for Sampling Site 4

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wn=K/Sn	Ideal value (Vo)	Mean concentration value (Vn)	Vn/Sn	Qn=Vn/Sn*100	WnQn
Electronic Conductivity (μScm-1)	500	0.002	4.53404	0.2206	0.00044	0	300	0.60	60.00	0.02647
Iron, Fe (mg/l)	0.3	3.33333	4.53404	0.2206	0.73518	0	0.5	1.67	166.67	122.53
Nitrate NO_3 (mg/l)	45	0.02222	4.53404	0.2206	0.00490	0	3.631	0.08	8.07	0.03955
Fluoride F (mg/l)	1.5	0.66667	4.53404	0.2206	0.14704	0	0.145	0.10	9.67	1.42135
p^H	8.5	0.11765	4.53404	0.2206	0.02595	7	7.22	0.85	84.94	2.20401
Turbidity	5	0.2	4.53404	0.2206	0.04411	0	2.7	0.54	54.00	2.38198
Total alkalinity (mg/l)	200	0.005	4.53404	0.2206	0.00110	0	30	0.15	15.00	0.01654
Total Hardness (mg/l)	300	0.00333	4.53404	0.2206	0.00074	0	160.8	0.54	53.60	0.03941
TDS (mg/l)	500	0.002	4.53404	0.2206	0.00044	0	255	0.51	51.00	0.0225
Calcium, Ca^{2+} (mg/l)	200	0.005	4.53404	0.2206	0.00110	0	31.5	0.16	15.75	0.01737
Magnesium, Mg^{2+} (mg/l)	150	0.00667	4.53404	0.2206	0.00147	0	9.60	0.06	6.40	0.00941
Sulphate SO_4 (mg/l)	400	0.0025	4.53404	0.2206	0.00055	0	5.164	0.01	1.29	0.00071
Chloride, Cl (mg/l)	1000	0.001	4.53404	0.2206	0.00022	0	52.00	0.05	5.20	0.00115
		4.53404			**1.0000**					**133.65**

Table 7.7: Calculation of Water Quality Index for Sampling Site 5

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wn=K/Sn	Ideal value (Vo)	Mean concentration value (Vn)	Vn/Sn	Qn=Vn/Sn*100	WnQn
Electronic Conductivity (µScm-1)	500	0.002	4.53404	0.22055	0.0004	0	466	0.93	93.20	0.04
Iron, Fe (mg/l)	0.3	3.333	4.53404	0.22055	0.7352	0	0.48	1.60	160.00	117.63
Nitrate NO_3 (mg/l)	45	0.022	4.53404	0.22055	0.0049	0	4.852	0.11	10.78	0.05
Fluoride F (mg/l)	1.5	0.667	4.53404	0.22055	0.1470	0	0.173	0.12	11.53	1.70
p^H	8.5	0.118	4.53404	0.22055	0.0259	7	7.54	0.89	88.71	2.30
Turbidity	5	0.200	4.53404	0.22055	0.0441	0	3.3	0.66	66.00	2.91
Total alkalinity (mg/l)	200	0.005	4.53404	0.22055	0.0011	0	35	0.18	17.50	0.02
Total Hardness (mg/l)	300	0.003	4.53404	0.22055	0.0007	0	158.3	0.53	52.77	0.04
TDS (mg/l)	500	0.002	4.53404	0.22055	0.0004	0	243	0.49	48.60	0.02
Calcium, Ca^{2+} (mg/l)	200	0.005	4.53404	0.22055	0.0011	0	31.5	0.16	15.75	0.02
Magnesium, Mg^{2+} (mg/l)	150	0.007	4.53404	0.22055	0.0015	0	9.76	0.07	6.51	0.01
Sulphate SO_4 (mg/l)	400	0.003	4.53404	0.22055	0.0006	0	4.015	0.01	1.00	0.001
Chloride, Cl (mg/l)	1000	0.001	4.53404	0.22055	0.0002	0	35	0.04	3.50	0.001
		4.53404			**1.000**					**124.79**

Table 7.8: Calculation of Water Quality Index for Sampling Site 6

Parameters	BIS standard (Sn)	1/Sn	∑1/Sn	K=1/(∑1/Sn)	Wn=K/Sn	Ideal value (Vo)	Mean concentration value (Vn)	Vn/Sn	Qn=Vn/Sn*100	WnQn
Electronic Conductivity (µScm-1)	500	0.002	4.53404	0.2206	0.0004	0	497	0.994	99.4	0.04
Iron, Fe (mg/l)	0.3	3.33333	4.53404	0.2206	0.7352	0	0.45	1.5	150	110.28
Nitrate NO_3 (mg/l)	45	0.02222	4.53404	0.2206	0.0049	0	5.5	0.122	12.22	0.06
Fluoride F (mg/l)	1.5	0.66667	4.53404	0.2206	0.1470	0	0.134	0.09	8.93	1.31
p^H	8.5	0.11765	4.53404	0.2206	0.0259	7	7.45	0.88	87.65	2.27
Turbidity	5	0.2	4.53404	0.2206	0.0441	0	5	1	100	4.41
Total alkalinity (mg/l)	200	0.005	4.53404	0.2206	0.0011	0	31	0.155	15.5	0.02
Total Hardness (mg/l)	300	0.00333	4.53404	0.2206	0.0007	0	135	0.45	45	0.03
TDS (mg/l)	500	0.002	4.53404	0.2206	0.0004	0	246	0.492	49.2	0.02
Calcium, Ca^{2+} (mg/l)	200	0.005	4.53404	0.2206	0.0011	0	32.16	0.1608	16.08	0.02
Magnesium, Mg^{2+} (mg/l)	150	0.00667	4.53404	0.2206	0.0015	0	10.81	0.07204	7.203978	0.01
Sulphate SO_4 (mg/l)	400	0.0025	4.53404	0.2206	0.0006	0	6.896	0.01724	1.724	0.001
Chloride, Cl (mg/l)	1000	0.001	4.53404	0.2206	0.0002	0	40	0.04	4	0.001
		4.53404			**1.0000**					**118.47**

Table 7.9: Weighted Arithmetic Water Quality Index Values

WQI(Rating)

Sampling Site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Observed Value	81.777	142.25	123.93	128.71	124.79	118.48
	Very poor	Unsuitable for drinking purpose	Unsuitable for drinking purpose	Unsuitable for drinking purpose	Unsuitable for drinking purpose	Unsuitable for drinking purpose

From the above table, it is seen that the Weighted Arithmetic WQI values of Mori Kolong Beel ranges from 81.777 to 146.25 According to Weighted Arithmetic Water Quality Index values water sample of Site 2 i.e., Borghat (Nagaon-Lumding road) is most polluted among all the collected water sample, which falls under "Unfit for drinking" rating.

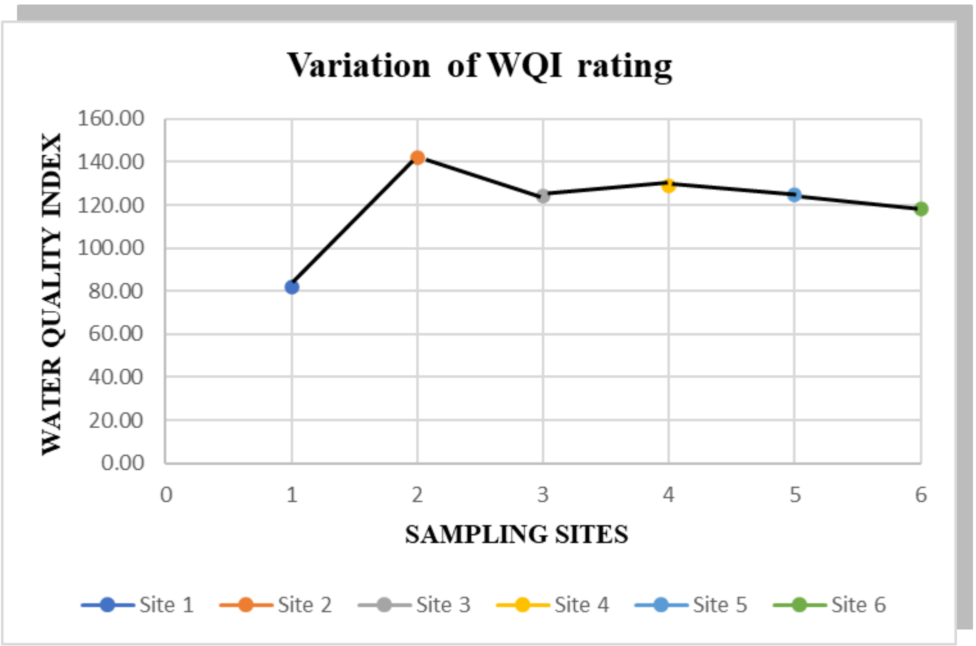


Figure 7.1: Variation of Water Quality Index Values of 6 sampling site

CHAPTER 8

CONCLUSION

Water quality Index is helpful in assessment and management of water quality. The case study provides valuable information into the status of overall suitability of the Mori Kolong Beel water based on WQI values. This study highlights the salient features of various important physio-chemical parameters acting upon the general water quality of the Beel. Again, there are also variations in water quality in six different sampling sites distributed along the bank of the Beel. The baseline data generated in this investigation and their analysis and interpretation will help in understanding about the status of water quality of the Mori Kolong Beel and the factors affecting the overall water quality of its water. This study has both academic value and practical significance also might be helpful in optimum utilization and sustainable management of the Mori Kolong Beel. Based on observed WQI results it can be concluded that the water of Mori Kolong Beel is not fit for direct consumption but might be used for irrigation or agricultural purposes and must therefore be treated before use to avoid diseases. This quality of wetland water may cause harm to the sensitive aquatic life and aqua-environment. The effective treatment measures are urgently required to augment the Beel water quality by defining an appropriate water quality management process which will support any future plan for sustainable wetland restoration. Water quality of the Mori Kolong Beel needs to restored by adapting measures like restricting inflows of raw sewerage from residential areas, preventing dumping of solid waste by nearby locality along with the Mori Kolong Beel.

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