

STUDY ON SPATIAL VARIABILITY OF GROUND WATER QUALITY IN WASHERMANPET CHENNAI

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Civil Engineering
by

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

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DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that the Project Report is the bonafide work of DINESHKUMAR.D (Reg. No. 37200020) and SANATHRAJ.S (Reg. No. 37200907) who carried out the project entitled "**STUDY ON SPATIAL VARIABILITY OF GROUND WATER QUALITY IN WASHHERMANPET CHENNAI**" under my supervision from December 2020 to April 2021.

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DECLARATION

We DINESHKUMAR.D (Reg. No. 37200020) and SANATHRAJ.S (Reg. No. 37200907) hereby declare that the Project entitled “STUDY ON SPATIAL VARIABILITY OF GROUND WATER QUALITY IN WASHERMANPET CHENNAI” done by us under the guidance of Ms. P.Eshanthini M.E, at Sathyabama Institute of Science and Technology, Chennai is submitted in partial fulfillment of the requirement for the award of Bachelor of Engineering Degree in Civil Engineering.

1.

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ABSTRACT

Water is the basic would like of life and each living organism desires water to sustain .to get pure and clean water for drinking may be a basic right .the standard of groundwater in some elements of the country, notably shallow water is dynamic as a result of human activities .the standard of groundwater is of nice importance for human beings In developing countries has an enormous impact on Natural and artificial setting. Pollution supply increase with the event of cities and reason for contamination of air, water, and soil .water is the most supply of the water within the urban setting, that is employed for drinking industrial and domestic functions and sometimes, it's overexploited. Currently, days the bottom water is facing threats thanks to anthropogenic activities) Water is that the most significant in shaping the land and control the climate. It's one of the foremost vital compounds that deeply influence life .the standard of water is sometimes delineated and per its physical, chemical, and biological characteristics.

The project can do the comparative study of the height of the bottom water levels, and chemical characteristics of the water .supported the results some improvement measures are steered for the event of water quality .within the elect block, groundwater quality, water level and were generated victimization ArcGIS software.

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGE NO.
	ABSTRACT	v
	LIST OF TABLES	viii
	LIST OF FIGURES	ix
1	INTRODUCTION	1
	1.1 GENERAL	1
	1.2 WATER QUALITY	1
	1.3 INTRODUCTION TO ARCGIS	2
	1.3.1 Components of ArcGIS	3
2	LITERATURE REVIEW	4
	2.1 GENERAL	4
	2.2 REVIEW OF THE LITERATURE	4
3	AIM AND SCOPE	13
	3.1 AIM	13
	3.2 SCOPE	13
4	MATERIALS AND METHODS	14
	4.1 METHODOLOGY	14
	4.2 STUDY AREA	15
	4.3 SAMPLE COLLECTION	16
	4.4 TESTING OF SAMPLES	18

CHAPTER NO.	TITLE	PAGE NO
4.4.1	pH	20
4.4.2	Calcium (Ca ²⁺) and Magnesium (Mg ²⁺)	20
4.4.3	Sulphate (SO ₄ ²⁻)	20
4.4.4	Chloride (Cl ²⁻)	20
4.4.5	Total Dissolved Solids (TDS)	20
4.4.6	Total Hardness as CaCO ₃	21
4.4.7	Total Alkalinity as CaCO ₃	21
4.4.8	Iron as Fe	21
4.4.9	Manganese as Mn	21
4.4.10	Silica as SiO ₂	22
4.4.11	Turbidity	22
4.5.12	Carbonate Hardness	22
5	RESULT AND DISCUSSION	23
5.1	GROUNDWATER CHEMISTRY	23
5.2	COMPARISION WITH STANDARDS	25
5.3	SPATIAL VARIATION OF WATER QUALITY PARAMETERS AND CONCENTRATION OF PARAMETER	26
6	SUMMARY AND CONCLUSION	45
	REFERENCES	46

LIST OF TABLES

TABLE No.	TITLE	PAGE No.
4.1	Details of sampling location	18
4.6	Testing Methods	19
5.1	Physicochemical Parameter	24
5.2	Comparison with Standards limits	25

LIST OF FIGURES

FIGURE No.	TITLE	PAGE No.
4.1	Methodology	14
4.2	Study Area Map	15
4.3	Sampling Location	17
5.1	Concentration of pH	26
5.2	Refers to spatial variation of pH	27
5.3	Concentration of Total Hardness	28
5.4	Refers to spatial variation of Total Hardness	29
5.5	Concentration of Calcium	30
5.6	Concentration of Total Alkalinity	31
5.7	Refers to spatial variation of Total Alkalinity	32
5.8	Concentration of Chloride	33
5.9	Refers to spatial variation of Chloride	34
5.10	Concentration of Magnesium	35
5.11	Refers to spatial variation of Magnesium	36
5.12	Concentration of Turbidity	37
5.13	Concentration of Sulphate	38
5.14	Refers to spatial variation of Sulphate	39

FIGURE NO.	TITLE	PAGE NO.
5.15	Concentration of Iron	40
5.16	Refers to spatial variation of Iron	41
5.17	Concentration of Manganese	42
5.18	Concentration of Total Dissolved Solids	43
5.19	Refers to spatial variation of TDS	44

CHAPTER 1

INTRODUCTION

1.1 GENERAL

The water covers about seventy of the planet's surface. Water is an important resource for individuals and therefore the environment. Water is the foundation of life; this makes up 60–95% of the total weight of any active living cell. However, in recent years, due to improved population, industrialization, urbanization, and improper sanitary water from multiple sources that receive "water quality" polluted water, the term used here to determine water conservation or the suitability of many processes. Vats can be done. Physical, chemical, or biological characteristics of water can be added to any direct use; for example restrictions on the concentration of toxins in alcohol consumption, or restrictions on the temperature and pH of water supporting invertebrate communities. As a result, water quality is often defined by a wide range of variables that reduce water consumption. While many uses have certain requirements such as shooting flexibility, each user may have their requirements and effects on water quality. Groundwater within cracks in sandy areas and rock formations can be a source of water below the Earth's surface. The depth in cracks and voids in those areas of soil or rock is filled with water called the water level. Groundwater is usually extracted for use by agriculture, municipalities, and industry through the creation and use of extraction resources. As it is usually cheaper, supplementation is easier and less risky than extra water. It is usually in its intrinsic value and as a sensitive indicator of changes or degradation in overall water quality, providing a useful complement to physical, chemical, and other information.

1.2 WATER QUALITY

The groundwater level depends on the length and response that occurs between the structure of the filled water, the contact between water and soil, the contact between soil and rock gas in space, and the topography. Therefore, great diversity is found, either in one place, especially where different songs and songs appear. The main processes affecting water quality in aquifers are physical (diffusion/purification, flow, and gaseous

flow), geochemical (visibility, acid-base reaction, chemical reaction, precipitation solution, and adsorption- desolation) and organic chemistry (of bacteria Respiration and effect) are. Caries, cell synthesis)

The groundwater level is affected by the effects of human activities resulting in the entry of pollution to the surface of the earth as a result of the large amount of groundwater generated by the replenishment of freshwater.

In some cases, public complaints about smells or tastes, outbreaks of waterborne diseases, or widespread death of aquatic species such as fish that kill fish can immediately lead to concerns about water quality. Because many water quality problems do not have clear or surprising results, it may not be easy to see the problem. Instead, several important water quality standards are routinely considered and compared to the water quality standards used for these parameters (Figure 4). Water quality standards are adopted by the provinces to protect a wide range of designated uses and are often targeted at ecoregions within the state. Ecoregions are geographic areas with landforms (see Table 3 for details). Regular monitoring allows countries to assess whether or not water level standards, and ultimately implemented, are met by a particular water user

1.3 INTRODUCTION TO ArcGIS

GIS (Geographic Information System) can be a powerful tool used for computer mapping and geographic analysis. GIS facilitates capturing, storing, querying, analyzing and displaying, and extracting location data

In this conference, we will be the victim of the tenth ArcGIS desktop, the most recent version of the popular GIS code created by ESRI. This course should reflect the basic GIS architecture of ArcGIS. However, we often hope that this seminar can get you started on misusing GIS and be happy about learning more.

1.3.1.1 COMPONENTS OF ArcGIS

The ArcGIS desktop consists of a group of integrated applications, accessible class measurements for your computer's first menu: ArcMap and ArcCatalog. ArcMap is an advanced map application that lets you create maps, analyze query attributes, local relationships, and make final edits. Arc Coast organizes location information on your laptop for different locations and viewing, previewing and handling data, and adding information for using geocoding services. The Arc Toolbox is the third application of the ArcGIS desktop. Although not available from the parent menu, ArcMap and ArcCatalog are frequently used and used. The Arc Toolbox has tools for geoprocessing, conversion, system integration, speculation, and more. This book may point to Arch pack and Arch cosmetics.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

The following major research program have been taken from international journals as a reference to analyze the concepts for the project

2.2 REVIEW OF THE LITERATURE

Kapil Rohilla et al., (2020) examined the suitable geostatistical approach utilized for planning different water quality boundaries and arranged a water quality guide for Mansa region, Punjab. Groundwater tests for different quality norms were gathered and investigated. PH, electrical conductivity (EC), carbonate and bicarbonate (CO_3^{2-} , HCO_3^-), chloride (Cl^-), calcium + magnesium ($\text{Ca}^{2+} + \text{Mg}^{2+}$) (absolute hardness), sodium (Na^+), lingering sodium carbonate (RSC)), potassium (K^+) and SAR. Different geostatistical approaches like straightforward water system, basic water system, and outspread premise work (RBF) and reverse distance weighting (IDW) were thought about dependent on the root mean square blunder to choose the best method for a specific boundary. EC and RSC inconstancy maps were coordinated to plan water quality in GIS conditions. Water quality guides were extensively delegated acceptable, minor, and poor dependent on EC and RSC esteems. The investigation followed the progressions utilizing the earlier year's water quality guide and water quality.

Manoj Kumar Karnena & Vara Saritha (2019). The waterfront regions of Srikakulam area in Andhra Pradesh were examined through pre and present storm seasons on decide the apportionment of water towards utilization through the Water

Quality Index (WQI). The current examination includes the assortment of subsurface water tests from inspecting locales assigned as divisional central command across the coast. To create WQI, physicochemical investigation of tests was 5 considering nine significant boundaries that included actual boundaries, for example, all out solute solids, pH, conductivity, synthetic boundaries like calcium and magnesium, sodium and potassium, chloride, and sulfate. Test locales are planned utilizing geographic data frameworks. GPS (Global Positioning System) was utilized to find the directions as far as scope and longitude. Relationship lattices of cation-particles are plotted utilizing a line plot from the estimations of the outcomes got through physio-substance investigation. Exploratory outcomes were exposed to measurable examination utilizing single direction ANOVA. In the current investigation, the WQI record was gotten in the scope of 57.6 to 989.1, demonstrating low quality water in these testing regions. The outcomes explained that the groundwater of the investigation zone required treatment prior to being utilized for utilization

Mary Kisaka et al., (2018). Examined groundwater quality boundaries and its spatial variety from the Makutopora borehole, which is discovered 32 km from the city of Dodoma. An aggregate of 90 examples (from profound and shallow wells) were gathered and broke down for different quality boundaries. The aftereffects of the examination were projected utilizing insights and backwards distance devices in a geographic data framework (GIS) climate to decide their spatial variety. The outcomes demonstrated that all examples were inside reasonable Tanzanian principles, aside from two unused creation boreholes, which showed more significant levels of absolute hardness, electrical conductivity, and complete disintegrated solids. In any case, net pollution was found in local area shallow wells of Chihanga and Veula, which showed undeniable degrees of nitrate (78–82 mg/L), manganese (1.05 mg/L), low pH (5.98) and E. coli. (52/100 ml). It is obvious from this examination that groundwater conveyed to Dodoma is as yet satisfying drinking water guidelines in Tanzania, albeit the spring was corrupted, which calls for pressing imaginative groundwater the executives. The outcomes acquired in this examination will hence be useful for future observing and supportable groundwater quality administration in the Makutopora sub-bowl.

Besma Tlili-Zrelli et al., (2018) Examined and assessed the spatial and worldly varieties of the hydroelectric compound qualities of Mawar Aquifer groundwater, a significant water asset in the north-east of Tunisia. The spring was liable to water quality corruption because of saline and nitrate pollution, and another appraisal of water quality was required. For this reason, 40 groundwater tests were gathered during wet and dry seasons and for saltiness, pH, T, O₂, significant concentrates and particles, and supplements utilizing standard strategies and water quality list (WQI) The examination was finished. The outcomes showed that most groundwater boundaries were not inside as far as possible set by the World Health Organization in the two seasons. The spatial circulation guides of the water quality record uncovered that unsettling the re-energize zone, the northwest and southeast pieces of the spring were found to have the best during the two seasons, while poor and helpless water quality was found in the outpouring was essential for Aquifer. As indicated by the sodium adsorption proportion (SAR) and Na% esteems, most groundwater tests were not appropriate for water system purposes and described the eastern piece of the spring and the outpouring part of the spring around the spring swamp

Shyamala et al., (2017). Evaluated groundwater quality in Mettupalayam, Tamil Nadu, and India to decide its reasonableness for drinking. Groundwater tests were gathered and decided their physicochemical qualities like pH, electrical conductivity (EC), absolute hardness (TH), all out broke up solids (TDS), Ca²⁺, Mg²⁺, SO₄²⁻ and Cl⁻. Was done and benchmarked with standard drinking water prerequisites. Varieties of these boundaries were spatially introduced. Groundwater is generally saline and hard and of low alkalinity and high saltiness. Therefore, groundwater is unacceptable for drinking without treatment in many pieces of the investigation zone. It is suggested that point and nonpoint wellsprings of groundwater contamination in Mettupalayam be recognized, observed, and oversaw for the security of groundwater.

Augustina Clara Alexander et al., (2017) Examined Geographical Information System (GIS) based groundwater quality record (GQI) to evaluate water quality in a mining bowl. The examination distinguished nine diverse water quality principles - accessible nitrate, sulfate, chloride, sodium, magnesium, calcium, broken up mineral solids, potassium, and fluoride (NO_3^- , SO_4^{2-} , Cl^- , Na^+ , Mg^{2+} , Ca^{2+}). Combined, DMS, DMS) K^+ and F^-) - from the 90 boreholes of the bowl by mathematical ordering comparative with World Health Organization principles. Studies looking at information for 2006 and 2011. The guide delivered showed a lower GQI of 67 of every 2011 contrasted with 72 out of 2011. The greatest GQI of 84.4 was determined well with the GQI utilizing just three boundaries (Mg^{2+} , K^+ , and F^-). Accomplished 84.6 utilizing every one of the nine models. A perceptible groundwater quality pattern was seen in many pieces of the bowl, especially in the southwestern and northern pieces of the bowl. Worldly variety between GQIs for 2006 and 2011 demonstrated variable groundwater quality (fluctuation = 15–30%) in zones around the mining zone, and surprisingly greater changeability (coefficient of variation > 30) in southwestern and eastern. %). Portions of the bowl.

Ehetshami et al., (2017) Evaluation of groundwater appropriateness for water system is essential for maintainable food creation. In this examination, the capacity of three insertion methods to mimic groundwater quality files for water system, for example, opposite distance burden, water system, and cooking water system: pH, Mg^{2+} , Ca^{2+} , Na^+ , TH, electrical conductivity (EC), sodium assimilation proportion (SAR)), Cl^- and SO_4^{2-} were analyzed. The aftereffects of the spatial design recommend that the factors and cross-approval of the nine factors can be reproduced threeely, specifically reverse distance, weighting, and water system. Information identified with 56 wells (with profundities of 30 and 60 m and distance across commonly somewhere in the range of 10 and 20 cm) were gathered in the suburb of Shiraz. After the standardization of the information, variograms were determined. The ideal variogram was picked dependent on least-squares esteem investigation. At that point, utilizing cross-approval, mean blunder and root mean square mistake examination, the addition model was chosen. The outcomes showed that for Mg^{2+} , Ca^{2+} , TH, EC, Cl^- and SO_4^{2-} coking had the least

root mean square blunder, and the weighting strategy for SAR and Na + reversal and pH, groundwater. To accomplish preferred outcomes over the land strategy for reproducing quality pointers. The pH, TH, EC, and Mg²⁺ + information were round and SAR, Ca²⁺ +, Na +, and Cl⁻—information for the Gaussian model, and SO₄²⁻—the information remarkable end up being the best semi fluctuation model. Besides, the outcomes announced that the cooking water system strategy was the awesome to its most elevated accuracy and least mistake. At long last, geographic data frameworks can all the more completely show the spatial example of value factors in the groundwater assets of the examination zone.

Kishan Singh Rawat et al., (2016). This examination is focused on spatial introduction strategies for planning groundwater synthetic quality. The precision of interjection strategies to spatially appraise soil and water properties have been investigated in a few examinations. Groundwater quality information and its spatial conveyance are significant for arranging and the executives. Geostatistical strategies are perhaps the most developed procedures for groundwater quality addition. In this investigation, flinching techniques were utilized to foresee the spatial circulation of some groundwater quality boundaries like Ca²⁺ +, Mg²⁺ +, Na +, K +, TDS, EC, F⁻, HCO₃⁻, NO₃⁻, Cl⁻, SO₄²⁻. Furthermore, PO₄²⁻. Information were gathered from 13 wells in Mathura locale (Uttar Pradesh, India). After the standardization of the information, a semivariogram was readied. To choose the fitting model for wellness on the exploratory semi-variogram, the lingering amount of squares (RSS) esteem was utilized. The utilization of geostatistics (i.e., kriging) on our great examining results gives important experiences into the idea of the spatial and worldly fluctuation of groundwater quality boundaries. In the investigation, higher estimations of NO₃⁻ (= 104.77 mg/l), K + (= 141.51 mg/l), PO₄²⁻ (= 2.99 mg/l) and most extreme 4.6 mg/l (in Shahpur) with higher F⁻ esteems. Huh. Seen in groundwater tests.

Smita Rout et al., (2016) Appraisal and recognition of Physico-compound properties of Mahanadi River water from five unique areas 500 m down stand (Binkhandi, 500 m upstream, Binkhandi) of Sambalpur city, Bambakhandi, PC Bridge and Dhanbali, Odisha during this month the investigation was accomplished for March and August 2014. Investigation taking some significant boundaries like pH, disintegrated oxygen (DO), natural oxygen interest (BOD), synthetic oxygen interest (COD), chloride, all out broke up oxygen (TDS), nitrate, sulfates, absolute hardness (TH) was finished.), Electrical conductivity (EC), and fluoride. Investigated boundaries like pH, DO, TH, chloride, sulfate 4 And TDS were discovered to be inside as far as possible set by IS 10500, barring nitrate and fluoride content, which is higher at certain destinations.

Satyajit Kataki et al., (2015) having contemplated the pre-storm and post-rainstorm groundwater tests, considered the spatial changeability in compound nature of groundwater assets in pieces of Nagaon and Morigaon regions, Assam. Quality investigation was done through assessment of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, iron, sulfate, chloride, TDS, electrical conduction, all out hardness, and pH for both pre-storm and pre-rainstorm seasons. In light of these information, some compound boundaries, for example, sodium adsorption proportion (SAR), sodium rate (% Na), and lingering sodium carbonate (RSC) were acquired for the assessment of water system water quality. Topical guides of chosen boundaries were ready for both pre-and post-rainstorm seasons in the GIS climate. A land use/land cover guide of the examination territory was set up from satellite crises upheld with restricted field examinations. The reasonableness of groundwater for drinking and water system objects was checked dependent on the spatial appropriation of substance boundaries. Diverse groundwater quality zones were recognized dependent on the reasonableness of groundwater in the removal zone for farming area for drinking purposes and water system purposes. This was finished utilizing GIS by incorporating ground-water appropriateness maps with land use/land cover maps. The subsequent guide showed that groundwater from just a single area required treatment prior to being utilized for

drinking purposes. Additionally, a lot of the arable land is watered in the horticultural zone in the lowered region.

Manoj Kumar Tiwari et al., (2015) ten surface water tests were read each for the pre-storm and post-rainstorm gathered for investigation from the encompassing zones of a significant modern territory in Chhattisgarh. AAS investigation of surface water tests shows high convergences of some substantial metals over as far as possible. Allots Mn and Cr in pre-rainstorm tests brought about higher fixations and simultaneously as metals; Cu, Fe, and pH bring about lower focuses. Additionally, for post-rainstorm tests, Mn, Cr, and Fe were found with higher fixations, while Cu and pH brought about lower densities. A high number of found in weighty metals 10 the examples dissected propose that there is a genuine danger to the populace living in the connecting regions of the mechanical territory of Chhattisgarh. Subsequently, an enormous number of created mechanical squanders need legitimate removal.

Nadir Benhamiche et al., (2014) shown five-year observing of physicochemical boundaries with two missions in the low and high-water times of the Lower Sommm Catchment. The information from 18 wells were prepared by multivariate measurable instruments to distinguish key components influencing groundwater science. Two grids of 14 and 8 physicochemical boundaries were gotten with 18 groundwater tests gathered in the wells. The relationship network showed solid relationship between nine factors: K⁺, Ca²⁺, Na⁺, SO₄²⁻, Cl₂, Mg²⁺, NO₂⁻, Zn²⁺ and Sr²⁺. Head segment investigation and factor examination uncovered that the aggregate deviations of the great and low water time frames were 83.19% and 78.55%, separately. The factors allotted to mineralogical effect or contamination pointers were introduced by factor investigation. The bivariate plots affirmed a mineralization model, ascribed to undeniable degrees of salty tainting, the breaking down of land materials, and holes from clean frameworks. He likewise showed the way toward expanding the mineral's "upstream to downstream",

envisioning fleeting varieties, and distinguishing the mineral's weakening during the re-energize of the spring.

Pradipika Verma et al., (2014). Decided groundwater quality and evaluated the danger of groundwater defilement in Haridwar locale of Uttarakhand, India utilizing geostatistical methods. Groundwater quality boundaries (electrical conductivity) were dissected from existing wells in the Haridwar region and topical guides were readied utilizing geostatistical ideas. Conventional water system was utilized to dissect the spatial changeability of groundwater profundity and quality boundaries (electrical conductivity) with a focus equivalent to or more noteworthy than their separate groundwater pollution cut-off esteem, while pointer kriging was utilized for groundwater quality principles. Was utilized to break down equivalent to or more noteworthy than. Contamination limit esteem. It was seen that in the dramatic model for water profundity and water quality boundaries, the circular model fit the semi-variogram boundaries well. (Electrical conductivity and groundwater profundity followed by a log 1 Demonstrated a moderate spatial reliance as per the ordinary conveyance and the Dali proportion). The pointer kriging technique is valuable for surveying the danger of groundwater pollution by giving the contingent likelihood of convergences of various compound boundaries surpassing their shorts.

Nitasha Khatri & Sanjiv Tyagi et al., (2014) considered the impact of regular and anthropogenic components on a superficial level and groundwater quality in rustic and metropolitan zones. The surface nature of groundwater in provincial and metropolitan conditions is influenced by both characteristic cycles and anthropogenic effects. Because of this, there is a deficiency of water with an expanding populace all throughout the planet. Normal cycles prompting changes in water quality incorporate rocks enduring, vanishing, stores because of wind, filtering from the dirt, run-off due to hydrological factors, and natural cycles in sea-going conditions. These normal cycles change the pH and alkalinity of the water and lead to phosphorus stacking, expanded fluoride content, and higher groupings of sulfates. Anthropogenic elements influencing water quality incorporate

effects because of horticulture, utilization of manures, composts and pesticides, creature cultivation exercises, incompetent water system rehearses, deforestation, contamination because of hydroponics, mechanical squanders and homegrown sewage, mining, and sporting exercises. Are incorporated. These anthropogenic impacts cause high convergences of weighty metals, mercury, coliform, and supplement loads. This paper contemplates the impacts of regular cycles and human effects in country and metropolitan amphibian frameworks. Natural boundaries like substantial metal contamination, contamination because of weighty metals, and bacterial and pathogenic pollution of both metropolitan and rustic zones are talked about in detail.

Dash et al., (2010). Investigated the spatial variability of groundwater depth and levels of pollutant concentrations in the area. Therefore, in this study, an attempt was made to create spatial variability maps of groundwater depth and quality parameters (ie, chloride, electrical conductivity, fluoride, magnesium, and nitrate). Simple irrigation was used to analyze the spatial variability of groundwater depth and quality parameters, while indicator kriging was used to analyze groundwater quality parameters equal to or exceeding pollution threshold values. It was seen that 12 Semivarium parameters fitted well in the exponential model for water depth and the spherical model for water quality parameters. The spatial variability maps generated indicated that groundwater depth was within 20 m in 43% of the study area. Salinity levels were higher than 2.5 ds m⁻¹ in 69% of the study area and nitrate concentrations were higher than 45 mg l⁻¹ in 36% of the area. The probability map shows that approximately 24% of the area had the highest probability of exceeding the threshold electrical conductivity value (0.8–1.0) and that the area of 2% exhibited the highest probability of exceeding the threshold value of nitrate concentrations in groundwater. The spatial variability and probability maps generated will assist water resource managers and policymakers to develop guidelines injudicious management of groundwater resources for agricultural and drinking purposes in the study area

CHAPTER -3

AIM AND SCOPE

3.1 AIM

The project aims to analyze groundwater quality in Washermanpet Chennai, Tamil Nadu. The present study aimed to determine the parameters of groundwater quality standards in different washermanpet area

3.2 SCOPE

1. To monitor the contamination of water quality
2. To create awareness among the people about the pollution of groundwater
3. To check the chemical characteristics of the groundwater

CHAPTER 4

MATERIALS AND METHODS

4.1 METHODOLOGY

The methodology of this project includes a collection of samples, testing of samples, and analysis of the groundwater. Fig 4.1 shows the methodology of the work

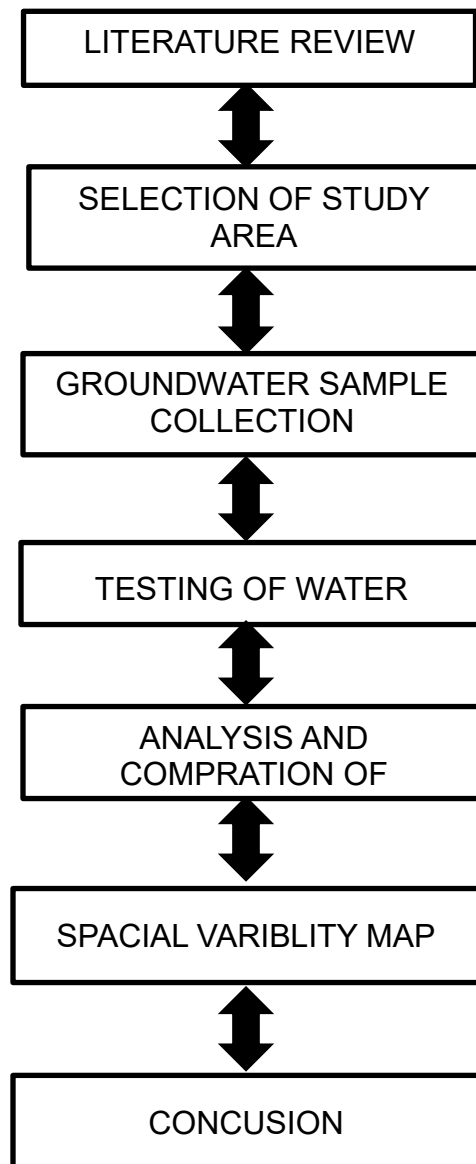


Fig: 4.1: Methodology

4.2 STUDY AREA

The latitude and longitude of Chennai city $13^{\circ}04'57.7''\text{N}$ and $80^{\circ}16'14.5''\text{E}$. Washermanpet is located in the north of Chennai city, Tamil Nadu, India, and it is bounded by the Kosathaliyar river Washermanpet creek and Bay of Bengal. The average annual rainfall in the study area is 140 cm It was recently merged with Chennai city. Washermanpet is surrounded by the hub range of the industrial project, mainly thermal power stations and industrials ports. Fig 4.2 shows the study area map.

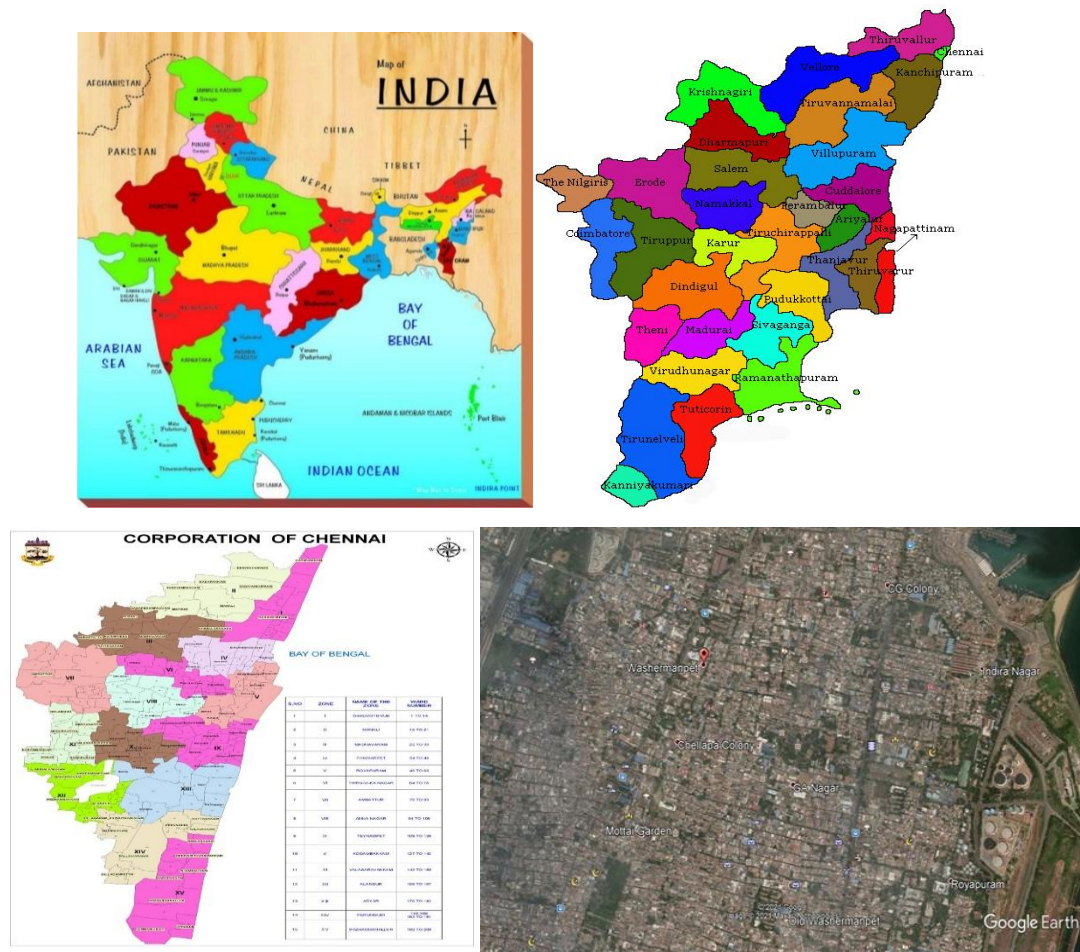


Fig: 4.2: Study Area Map

4.3 SAMPLE COLLECTION



Fig: 4.3.1: Picture of sampling location



Fig: 4.3.2: Picture of sampling location

Ten samples were collected to evaluate the quality of groundwater during the rainy season (January 2021) from the various sources represented in Table 4.4. Groundwater samples are collected in clean polyethylene bottles. At the time of sampling, the bottles were thoroughly cleaned two or three times with groundwater to be extracted. Water samples are collected after purifying the water for 10-15 minutes to remove stagnant water as a normal procedure. Figure 4.5 shows a sample area of a study area.

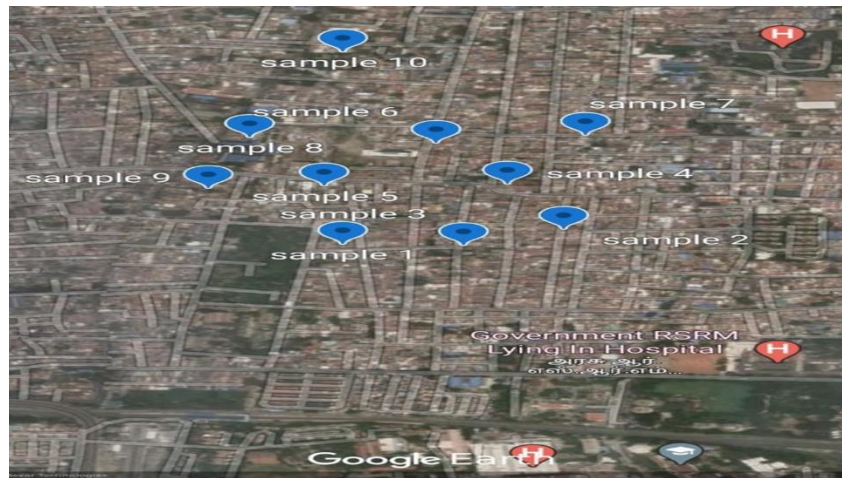


Fig: 4.5: Sampling Location

In this fig 4.5, it represents the sampling location of Washermanpet in which the area is selected by 2km of interval. From these areas, the water has been collected and tested the 12 parameters that are physic-chemical parameters.

s.NO	LOCATION	SAMPLING CODE	LATITUDES	LONGITUDES	SOURCE
1	T.H road	Sample 1	13°06'55"N	80°17'08"E	bore well
2	R.k nagar	Sample2	13°06'48"N	80°17'13"E	bore well
3	NN garden	Sample3	13°06'47"N	80°17'09"E	bore well
4	Ananadanayaki nagar	Sample4	13°06'53"N	80°17'12"E	bore well
5	Tondiarpet market	Sample5	13°06'54"N	80°17'05"E	bore well
6	CG colony	Sample6	13°06'58"N	80°17'10"E	bore well
7	Anjaneya nagar	Sample7	13°06'57"N	80°17'16"E	bore well
8	GA road	Sample8	13°07'00"N	80°17'03"E	bore well
9	Mint	Sample9	13°06'55"N	80°17'00"E	bore well
10	Devi nagar	Sample10	13°07'08"N	80°17'09"E	bore well

Table 4.4: Details of sampling location

4.4 TESTING OF SAMPLES

Water temperature was measured at a site using a mercury thermometer while other parameters were determined in the laboratory within 48-72 hours of the sample following the standards. The following 12 water quality parameters were tested for collected samples including Total Hardness (CaCo₃), pH, Calcium (Ca²⁺), Magnesium (Mg²⁺), Sodium (Na⁺), Silica (SiO₂), Sulphate (SO₄²⁻), Chloride (Cl⁻), Carbonate Hardness, Total Dissolve Solids (TDS), Total Hardness (TH), Total Alkalinity (CaCO₃) and Table 4.6 show the accepted methods for testing different water quality parameters.

S.no	Parameter	Unit	Method
1.	pH	-	IS 3025 (Part 11)-1983 (R.2017)
2.	Magnesium	mg/l	IS 3025 (Part 46)- 1994 (R.2014)
3.	Sulphate	mg/l	IS 3025 (Part 24)-1986 (R.2014)
4.	Chloride	mg/l	IS 3025 (Part 32)-1988 (R.2014)
5.	TDS	mg/l	IS 3025 (Part 16)-1984 (R.2014)
6.	Iron	mg/l	IS 3025 (Part 53)-2003 (R.2014)
7.	Silica	mg/l	IS 3025 (Part 35)-1988 (R.2014)
8.	Turbidity	mg/l	IS 3025 (Part 10)-1984 (R.2017)
9.	Carbonate hardness	mg/l	IS 3025 (Part 21)-2009 (R.2014)
10.	Total hardness	mg/l	IS 3025 (Part 21)-2009 (R.2014)
11.	Calcium	mg/l	IS 3025 (Part 40)-1991 (R.2014)
12	Total Alkalinity	mg/l	IS 3025 (Part 23)-1986 (R.2014)

Table 4.6: Testing Methods

4.4.1 *pH*

pH is moderate but water is acidic/basic. Variations range from 0 -14, with seven neutral. A pH below 7 indicates acidity, and a pH larger than seven indicates a base.

4.4.2 *Calcium (Ca^{2+}) and Magnesium (Mg^{2+})*

A simple definition of water hardness is the amount of Calcium and magnesium dissolved in water. Heavy water contains a lot of soluble substances, both calcium, and magnesium.

4.4.3 *Sulphate (SO_4^{2-})*

Sulphate is one of the foremost dissolved elements of rain. High concentrations of sulfate within the water we tend to drink will have a laxative impact once combined with calcium and magnesium the 2 commonest constituents of hardness.

4.4.4 *Chloride (Cl^-)*

It's formed once the element chloride (a halogen) gains an electron or once a compound like acid is dissolved in water or alternative polar solvents. Chloride salt-like binary compounds are typically terribly soluble in water.

4.4.5 *Total Dissolved Solids (TDS)*

The Total Dissolved solids "seek advice from any minerals, salts, metals, solvents, or birds dissolved in water. The solids soluble solids (TDS) contain inorganic salts (especially Ca, magnesium, potassium, sodium, sodium, bicarbonates, chloride, and sulfates) and a small number of water-soluble organisms.

4.4.6 *Total Hardness as CaCO_3*

A precise explanation for the hardness of water is that the amount of calcium and magnesium dissolved. H_2O is high in dissolved minerals, Ca and Mn each. When H_2O is heated, it is like a very home heater, solid carbonate deposits.

4.4.7 *Total alkalinity as CaCO_3*

Total alkalinity is a water element that measures the force of water to reduce acids, that is, to receive the elements H^+ ions. The naturally occurring pH varies from four hundred to five hundred mg / L. As an example of a degree, calculate the pH if one L of water contains zero 35 g of HCO_3^- and 0.12 g of CO_3^{2-} carbonate ions.

4.4.8 *Iron as Fe*

Iron is in the water main in 2 types: it can be molten iron or insoluble iron. Water containing metallic element iron is visible and colorless due to the metal is dissolved. The point is that the transformation or style of the metal will not dissolve in water.

4.4.9 *Manganese as Mn*

Manganese is a mineral that occurs naturally on rocks and soil and should be a gift for underground sources of pollution. Manganese is not found alone in many drinks of water. Money collected through pipelines and water can contain black and dark sewage due to the resulting Manganese.

4.4.10 Silica as SiO₂

Silica could be an arduous, glass-like mineral that's found dissolved in water as a result of the bedrock it passes through, like sandstone rock and granite. In well and surface water, it will vary from 1-100 elements per million as dissolved (reactive) or undissolved (colloidal) silica.

4.4.11 Turbidity

Turbidity is that the cloudiness or haziness of a fluid caused by massive numbers of individual particles that are usually invisible to the oculus, just like smoke in the air. The measuring of cloudiness could be a key take a look at of water quality.

4.4.12 Carbonate hardness

Carbonate hardness could be alive of the water hardness caused by the presence of carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) anions. Carbonate hardness is typically expressed either in degrees KH (dKH) or in elements per million carbonate (ppm CaCO_3).

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 GROUNDWATER CHEMISTRY

The result of the various physio–chemical parameters are presented in table 5.1.

The pH of all groundwater samples was almost neutral, a range of 6.6 to 7.5. The total hardness finished from 699 mg / L to 1873 mg / L. Hardness is an important factor for domestic and industrial purposes. The total hardness varies from 400 mg / L to 1160 mg / L.

Alkalinity is the absolute value of aquatic substances that can reduce acidity. Carbonates and hydroxide compounds in rocks are major sources of natural alkalinity. The total value of alkalinity is between 380 mg / L to 1160 mg / L. Chloride concentration was obtained at 242 mg / L to 787 mg / L. Sulphate ions concentration varied from 28 mg / L to 381 mg / L.

Ca^{2+} and Mg^{2+} cations are directly linked to the pH value. The higher the content of Ca^{2+} , the lesser the impact of Na^{+} and Cl^{-} . Ca^{2+} filtration varies from 86 mg / L to 224 mg / L. Mg^{2+} ranges from 35 mg / L to 153 mg / L. High levels of Magnesium in water will adversely affect soil quality and convert it into it is alkaline and lowers the yield.

Table: 5.1 Physicochemical Parameters

s.no	Tests	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1	Total hardness as (CaCo ₃)	mg/l	131	363	420	1041	449	350	300	501	440	539
2.	pH	—	7.4	7.0	7.2	7.2	7.3	6.9	6.7	7.2	7.5	7.6
3.	Calcium as (ca)	mg/l	36	106	145	165	137	106	117	82	125	137
4.	Magnesium as (Mg)	mg/l	10	24	14	153	26	21	20	72	22	48
5.	Turbidity	mg/l	2	8	<1	<1	1	<1	1	1	1	<1
6.	Iron as (Fe)	mg/l	0.24	0.53	0.06	0.10	0.12	0.06	0.09	0.13	0.1	0.05
7.	Silica as (SiO ₂)	mg/l	6.1	10.5	28.3	18.7	19.5	13.9	12	30.6	17	27
8.	Sulphate as (So ₄)	mg/l	39.6	168	98.6	262	203	209	207	216	200	52.1
9.	Chloride as (cl)	mg/l	81	314	223	1625	333	228	218	1012	320	318
10	Carbonate hardness	mg/l	130	273	420	315	357	189	176	410	342	284
11	Total Dissolved Solids	mg/l	348	1116	1148	3644	1358	952	980	2518	1400	998
12.	Total Alkalinity as (CaCo ₃)	mg/l	130	273	462	315	357	189	180	410	330	284

5.2 COMPARISION WITH STANDARDS

The number of samples exceeding the allowable limits set by BIS is given in table 5.2. The pH value of all the samples are within the permissible limit suggested by BIS. The TDS value of samples 4 and 8 three exceeding the permissible limits. High TDS levels result in excessive staining of water pipes. The calcium and chloride values of all the samples are exceeding the permissible limit suggested by BIS. The magnesium values of sample 4 are the exceeding permissible limit suggested by BIS. The sulphate values of all the samples are within the permissible limit. The sodium values of samples are within the limit suggested by BIS. The total hardness values of samples within the permissible limit suggested by BIS.

Table 5.2 Comparison with Standard Limits

Parameters	BIS STANDARDS		Within BIS standards	Without BIS standards
	Desirable	Max Permissible		
pH	6.5-8.5	6.5-8.5	S-1,2,3,4,5,6,7,8,9,10	NIL
TDS	300	1500	S-1,2,3,5,6,7,9,10	S-4,8
Ca	75	200	S-1,2,3,4,5,6,7,8,9,10	NIL
Mg	30	100	S-1,2,3,5,6,7,8,9,10	S-4
Cl	250	1000	S-1,2,3,5,6,7,8,9,10	NIL
SO ₄	250	400	S-1,2,3,5,6,7,8,9,10	NIL
TH	300	600	s-1,2,3,4,6,7,8,9,10	S-4

5.3 SPATIAL VARIATION OF WATER QUALITY PARAMETERS AND CONCENTRATION OF PARAMETERS

Concentration of pH

In this fig 5.1 and fig 5.2, it shows the spatial variation of pH in the study area. Sample 10 shows a higher concentration of pH and sample 7 is a lower concentration value of pH. The permissible limit of pH is 6.5 to 7.5mg/l. Increase content of pH in the water may cause ill effects.

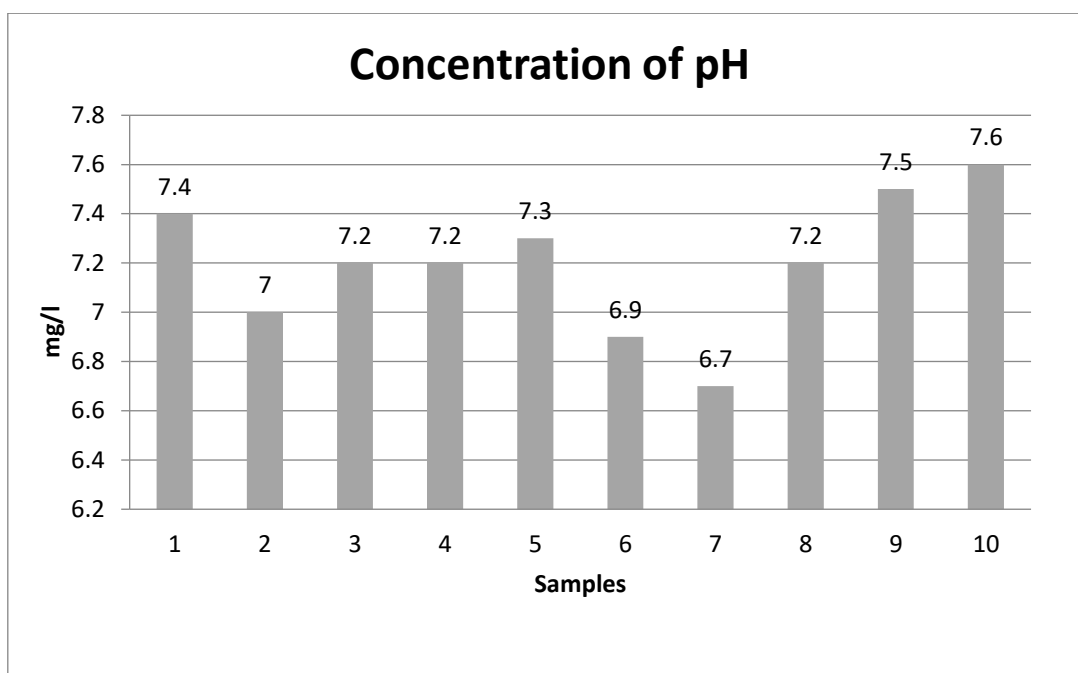


Fig: 5.1: pH

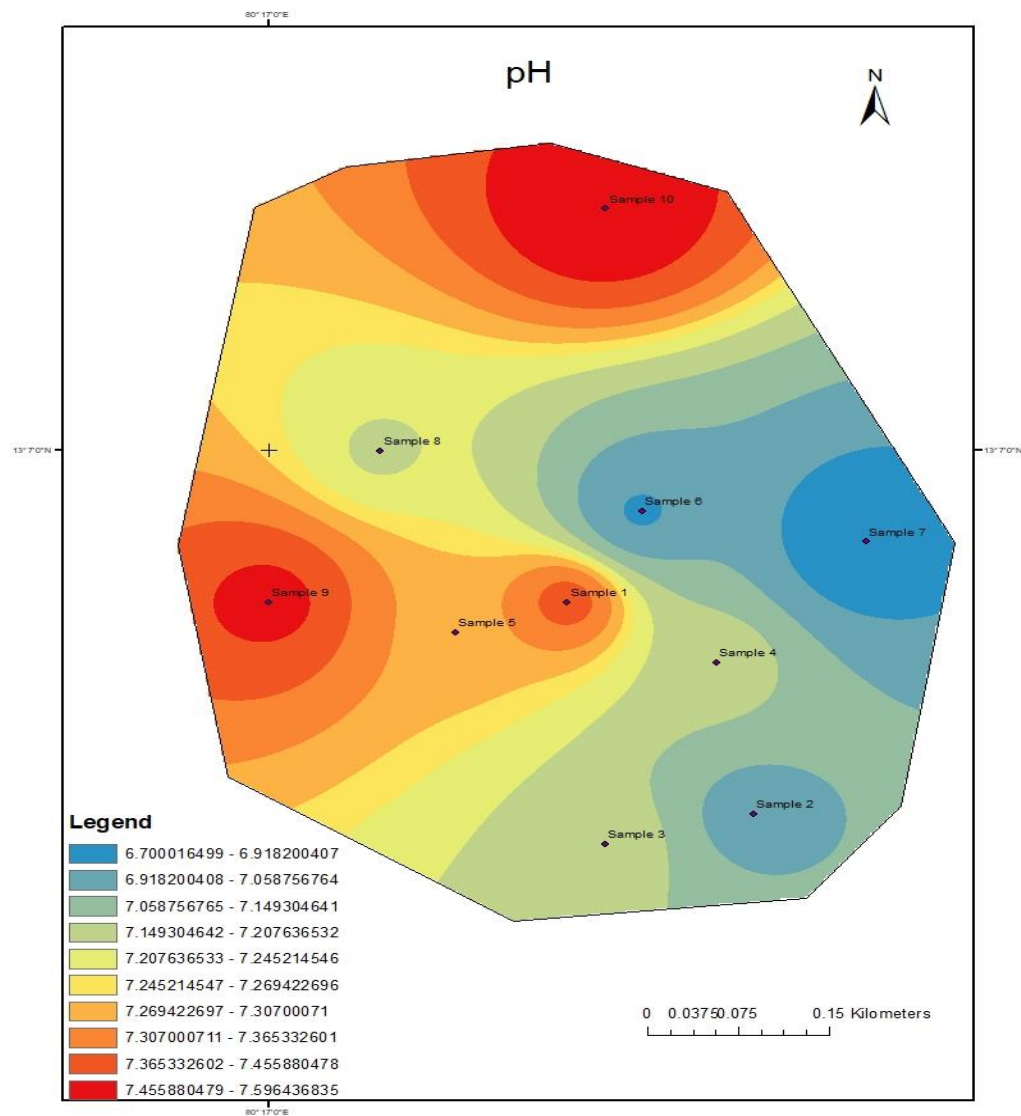


Fig. 5.2: Refers to spatial variation of pH

Concentration of Total Hardness

In this fig 5.3 and fig 5.4, it shows the spatial variation of Total Hardness in the study area. Sample 4 shows a higher concentration of Total Hardness and sample 1 is a lower concentration value of Total Hardness. The permissible limit of Total Hardness is 600mg/l. Increase content of TH in the water may cause ill effects.

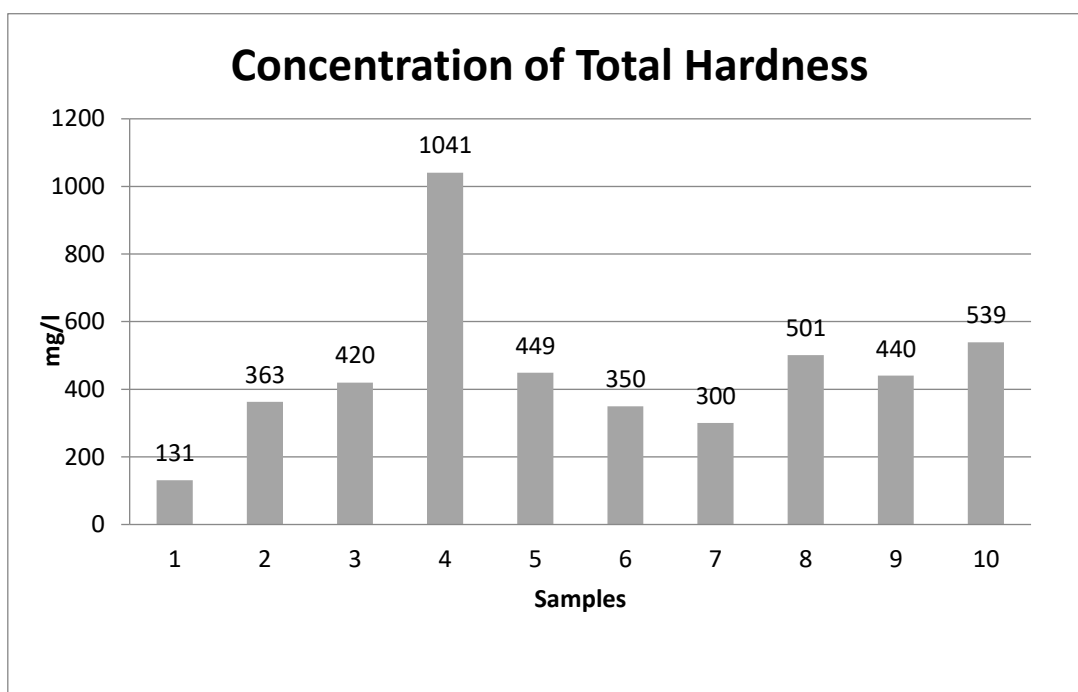


Fig: 5.3: Total Hardness

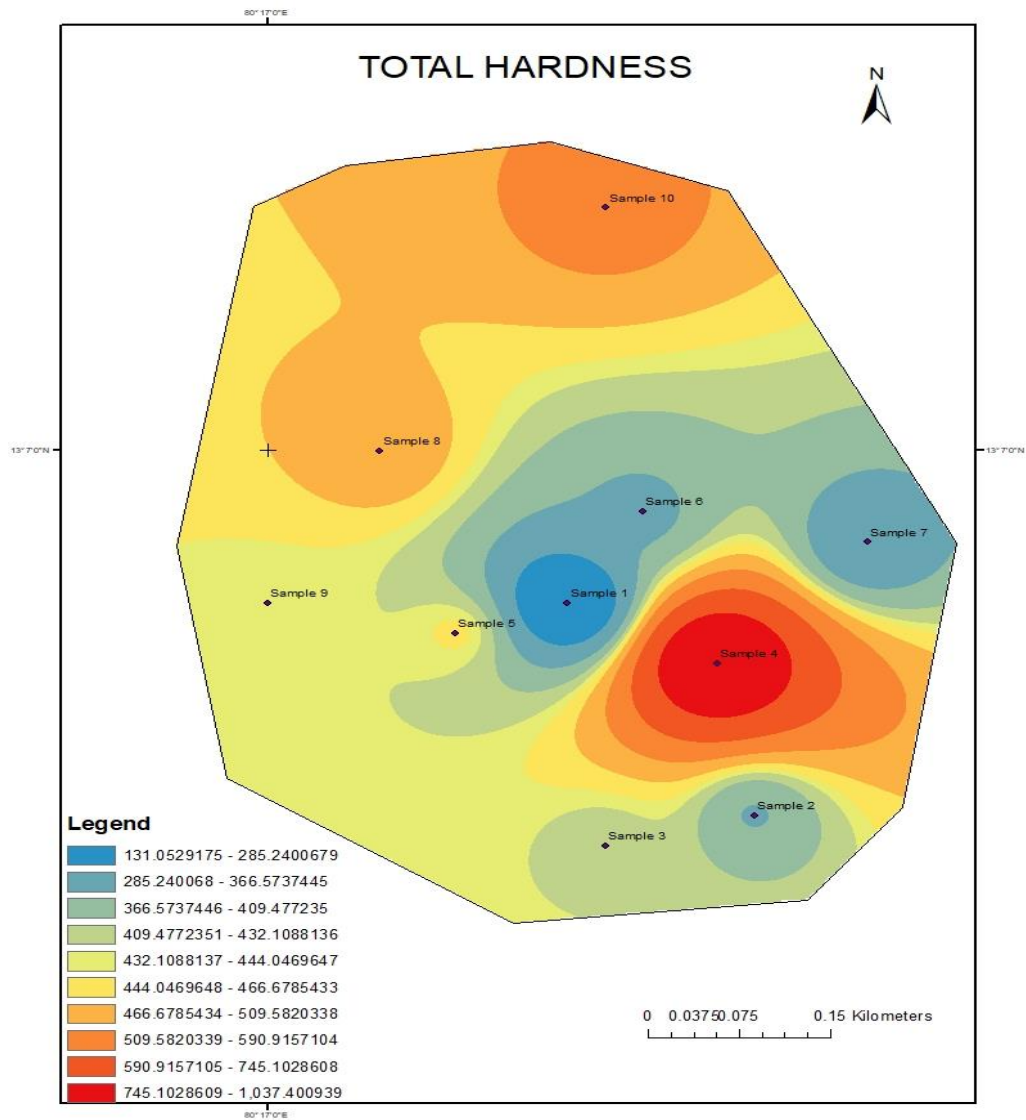


Fig: 5.4: Refers to spatial variation of Total Hardness

Concentration of Calcium

The calcium of all the samples are within the permissible limit shows in Fig 5.5

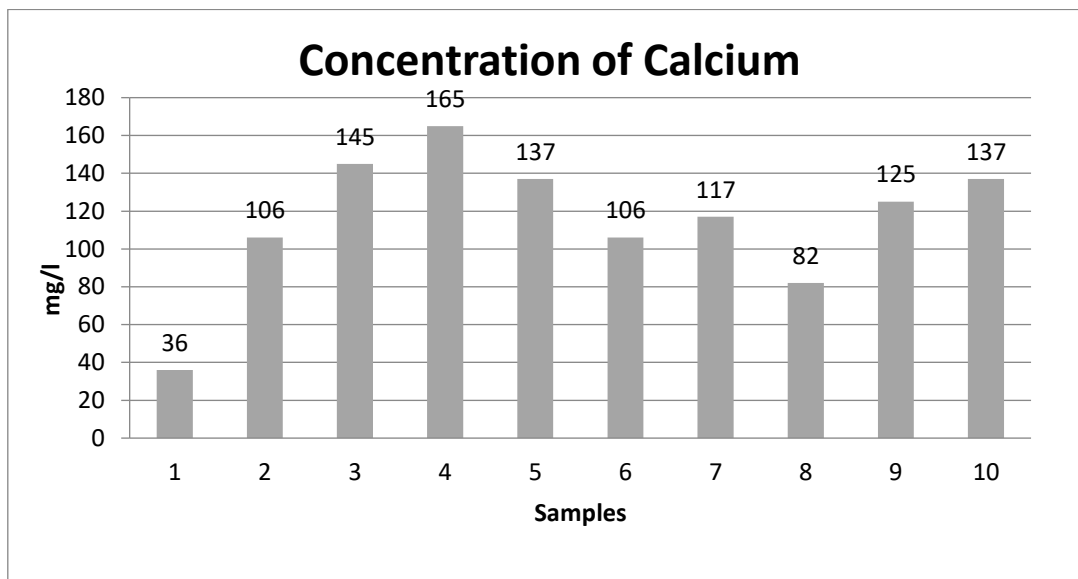


Fig: 5.5: Calcium

Concentration of Total Alkalinity

Fig 5.6 and fig 5.7 show the spatial variation of alkalinity in the study area. Within limits of alkalinity and sample 1 lower concentration of alkalinity value. The permissible limit of total alkalinity is 600mg/l. increase content of alkalinity in the water May causes ill effects.

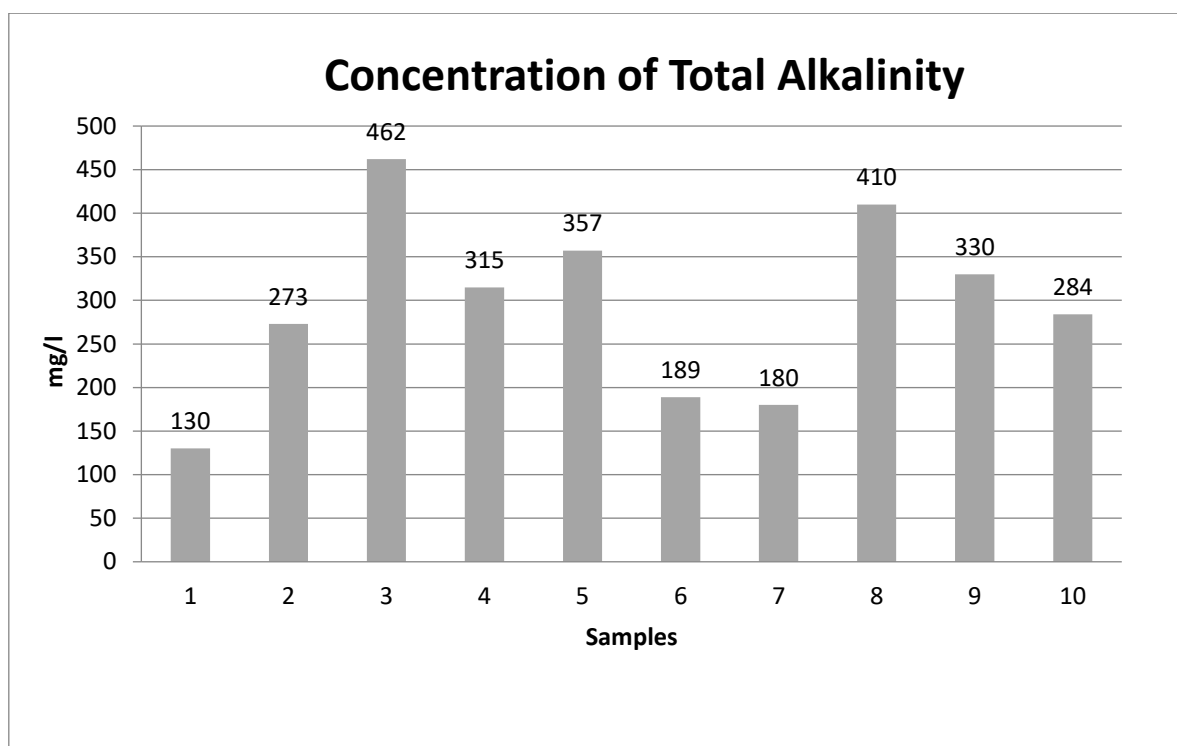


Fig: 5.6: Total Alkalinity

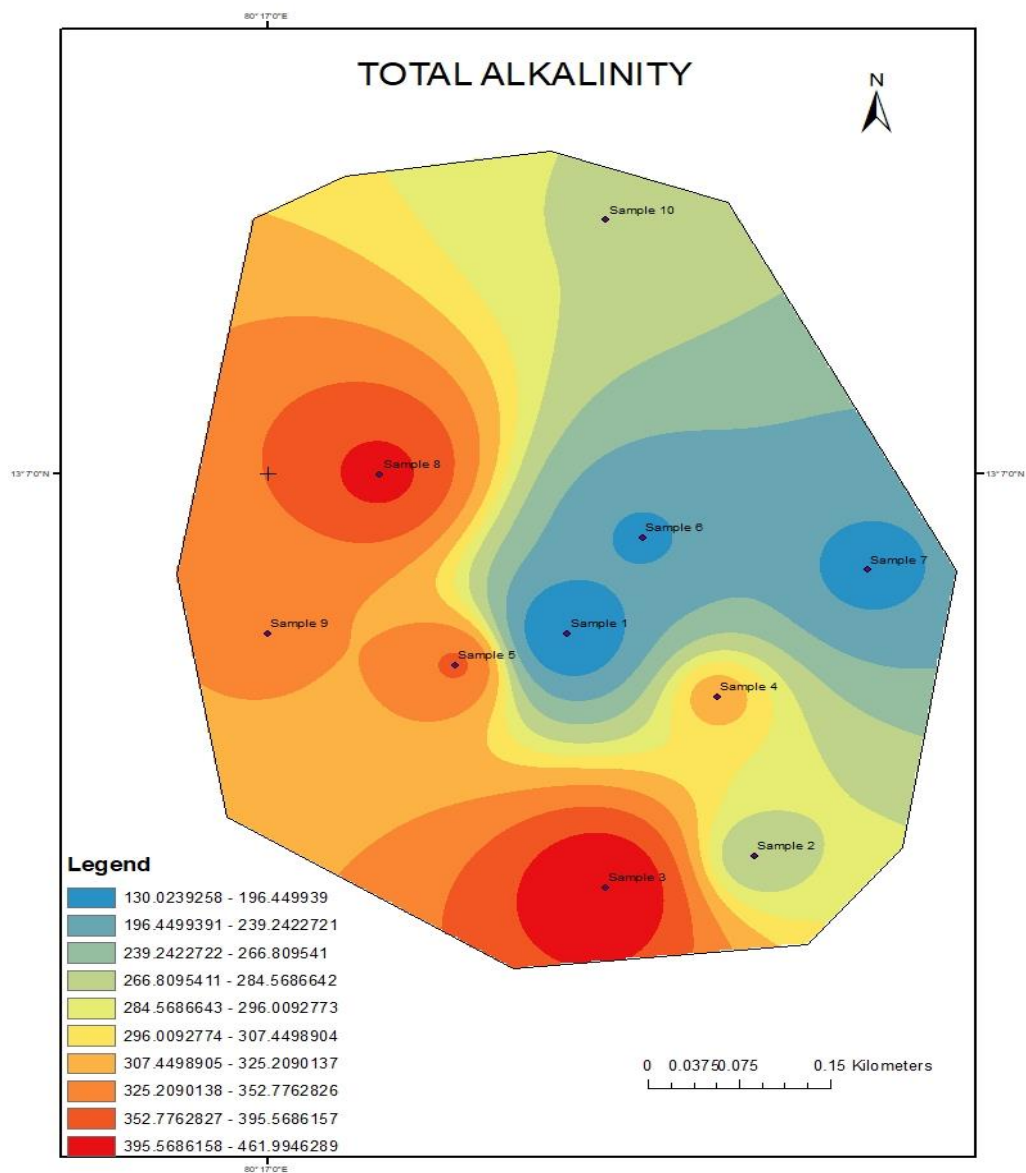


Fig. 5.7: Refers to spatial variation of Total Alkalinity

Concentration of Chloride

In this fig 5.8 and fig 5.9, it shows the spatial variation of chloride in the study area. Samples 4&8 show a higher concentration of chloride and sample 1 lower concentration of chloride value. The permissible limit of chloride is 250mg/l. Increase content of chloride in the water may cause ill effects.

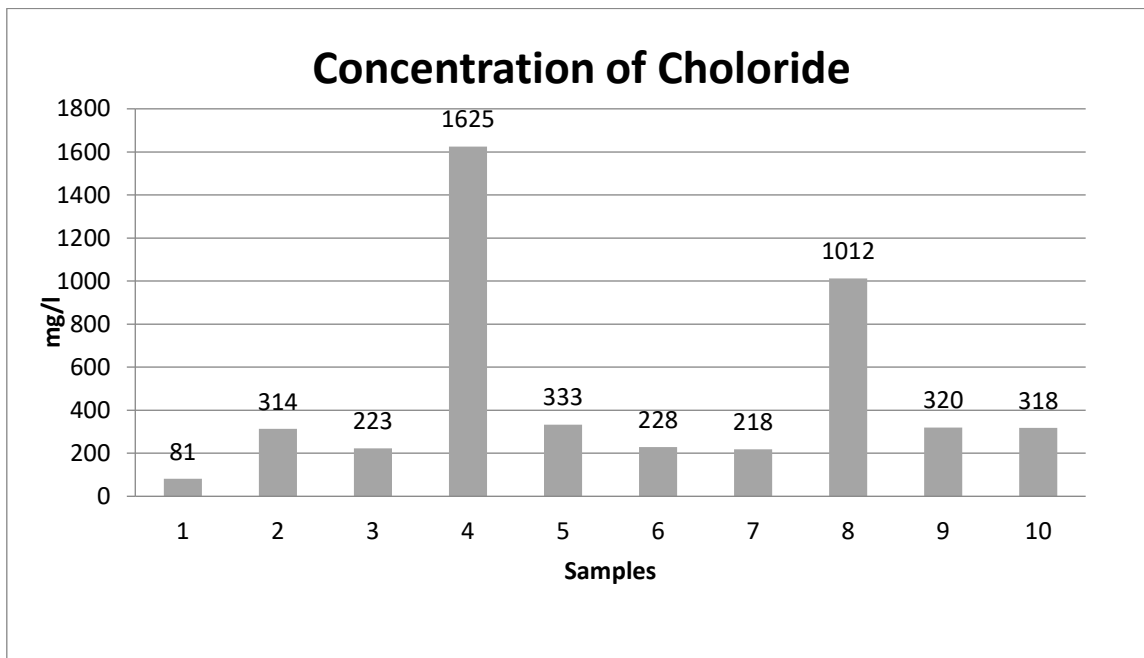


Fig: 5.8: Chloride

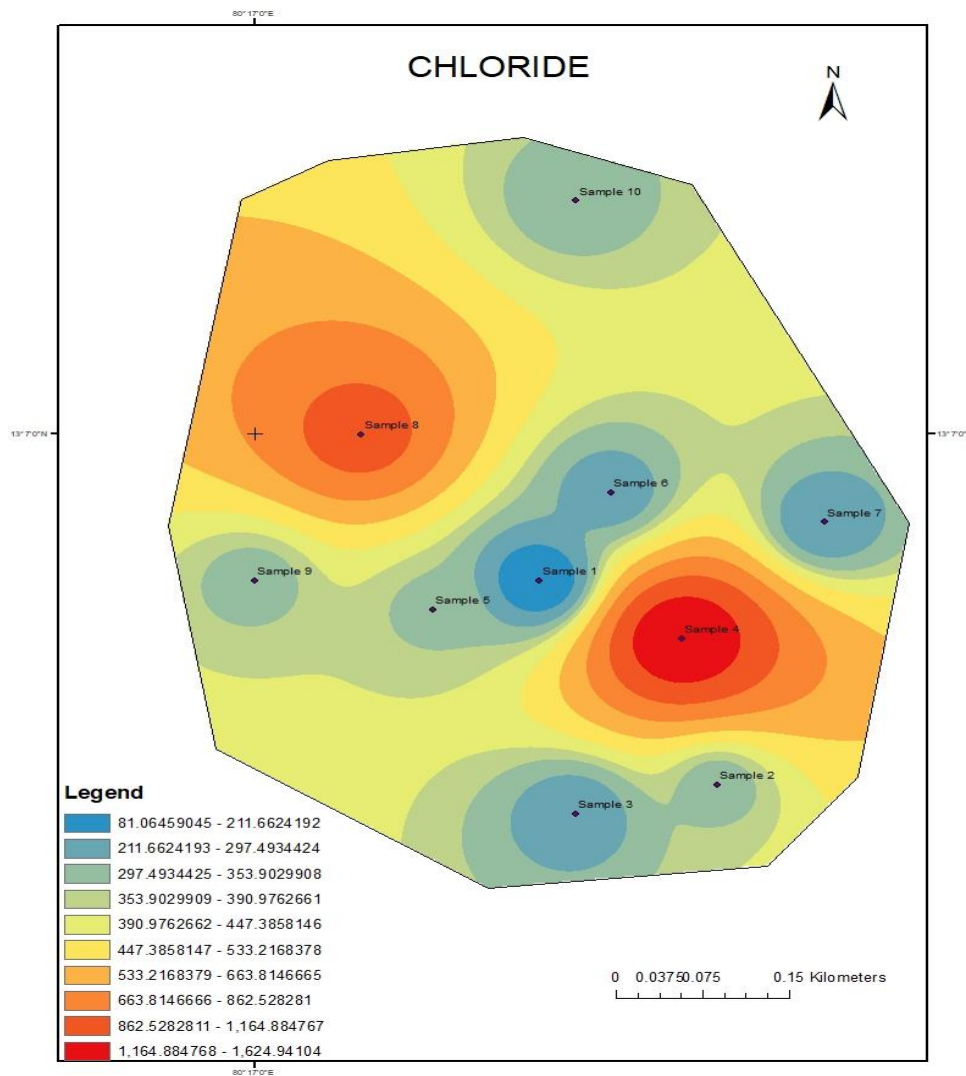


Fig: 5.9: Refers to spatial variation of Chloride

Concentration of Magnesium

In this fig 5.10 and fig 5.11, it shows the spatial variation of magnesium in the study area. Sample 4,8,10 shows a higher concentration of magnesium and sample 1&3 is a lower concentration value of magnesium. The permissible limit of magnesium is 30mg/l. Increase content of magnesium in the water may cause ill effects.

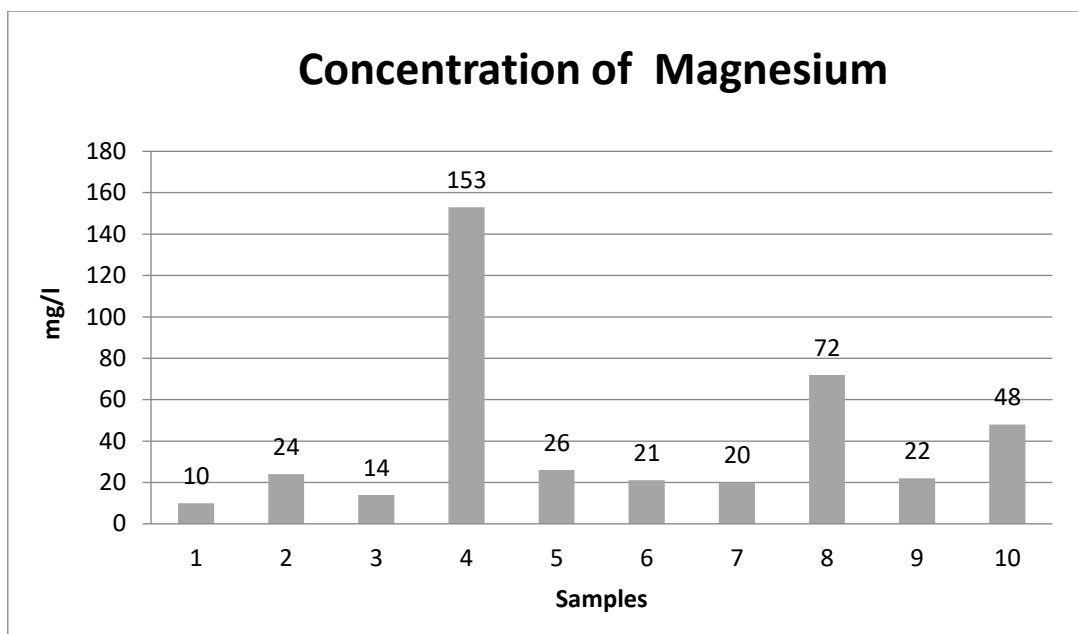


Fig: 5.10: Magnesium

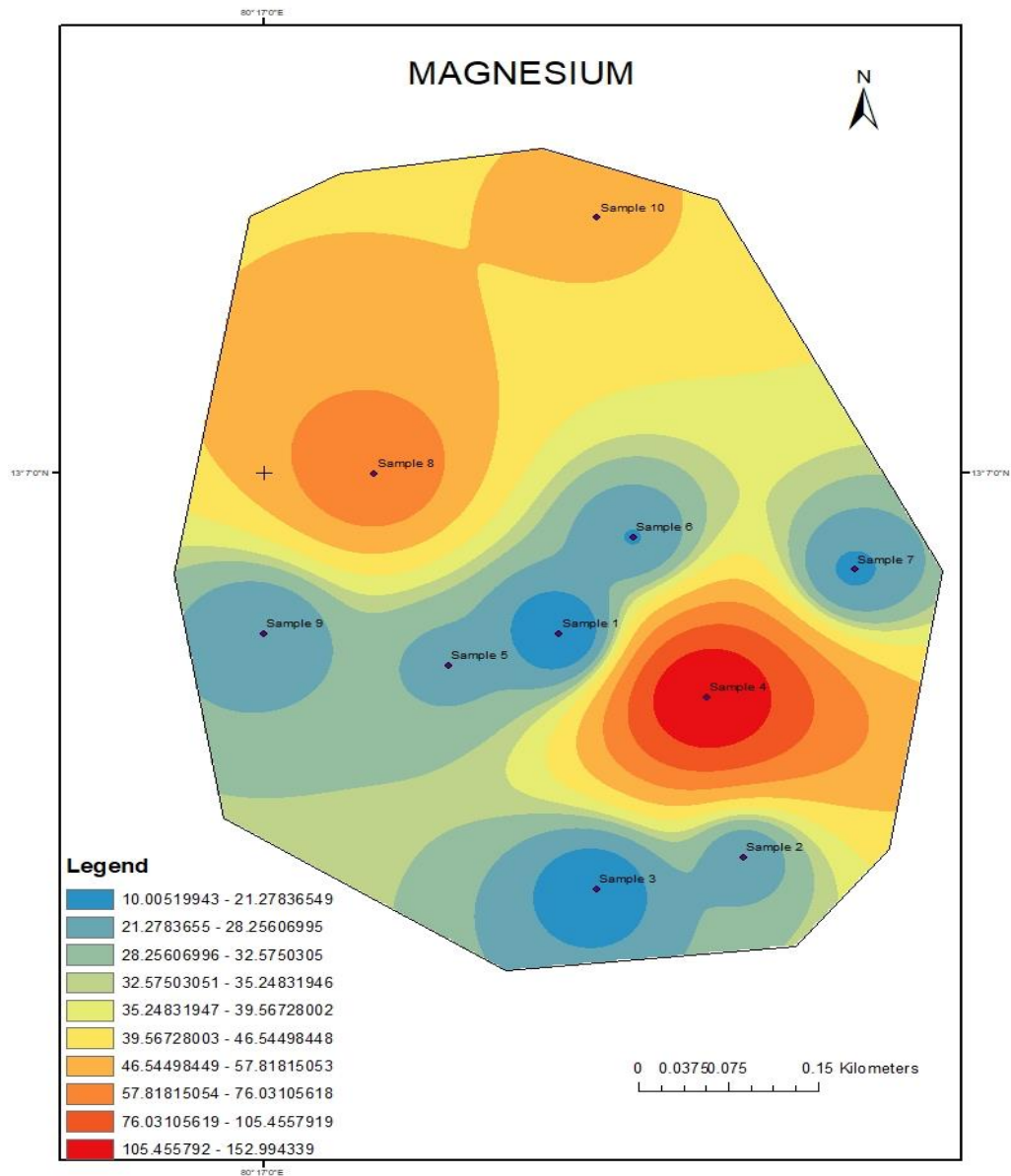


Fig: 5.11: Refers to spatial variation of Magnesium

Concentration of Turbidity

The turbidity of all the samples is within the permissible limit shows in Fig 5.12.

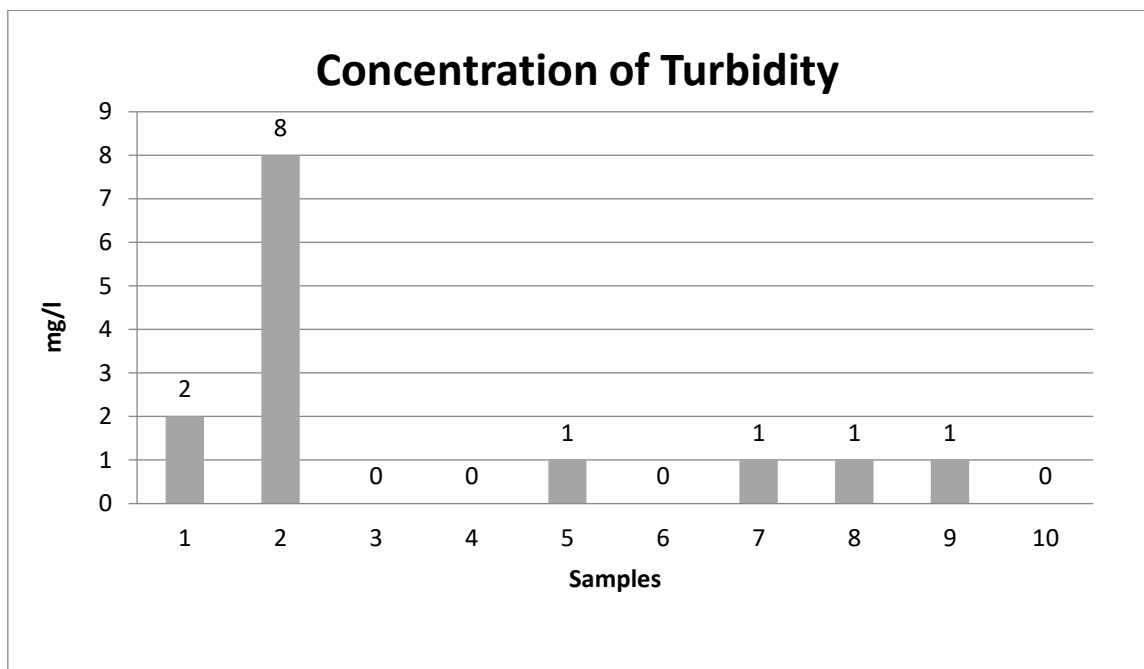


Fig: 5.12: Turbidity

Concentration of Sulphate

In this fig 5.13 and fig 5.14, it shows the spatial variation of sulfates in the study area. Sample 4 shows a higher concentration of sulphate and sample 1,3,10 is a lower concentration value of sulphate. The permissible limit of sulphate is 250mg/l. Increase content of sulphate in the water may cause ill effects.

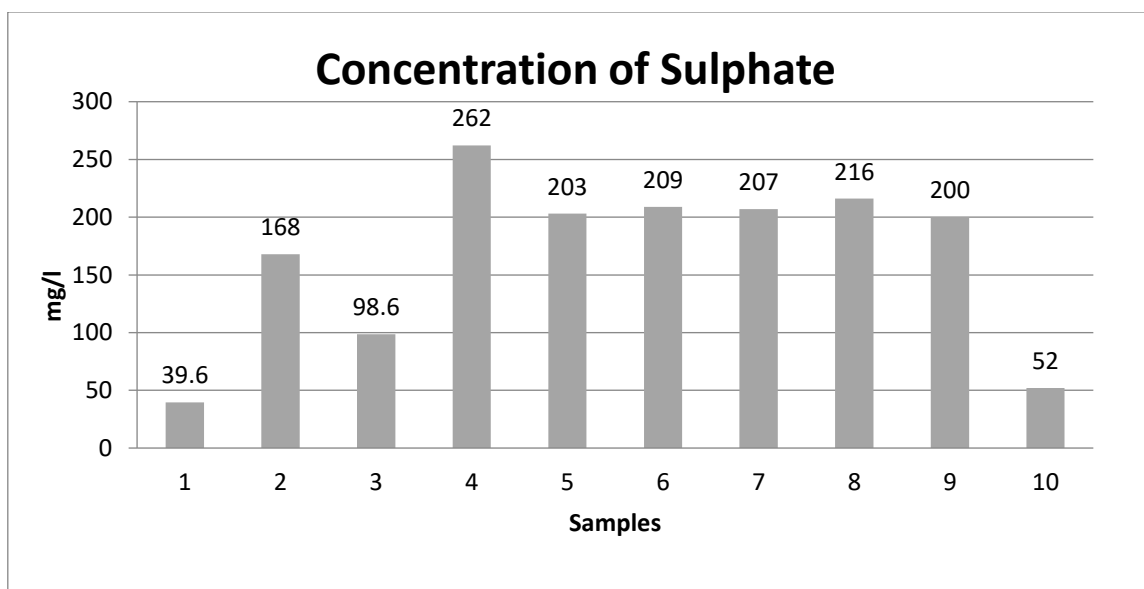


Fig: 5.13: Sulphate

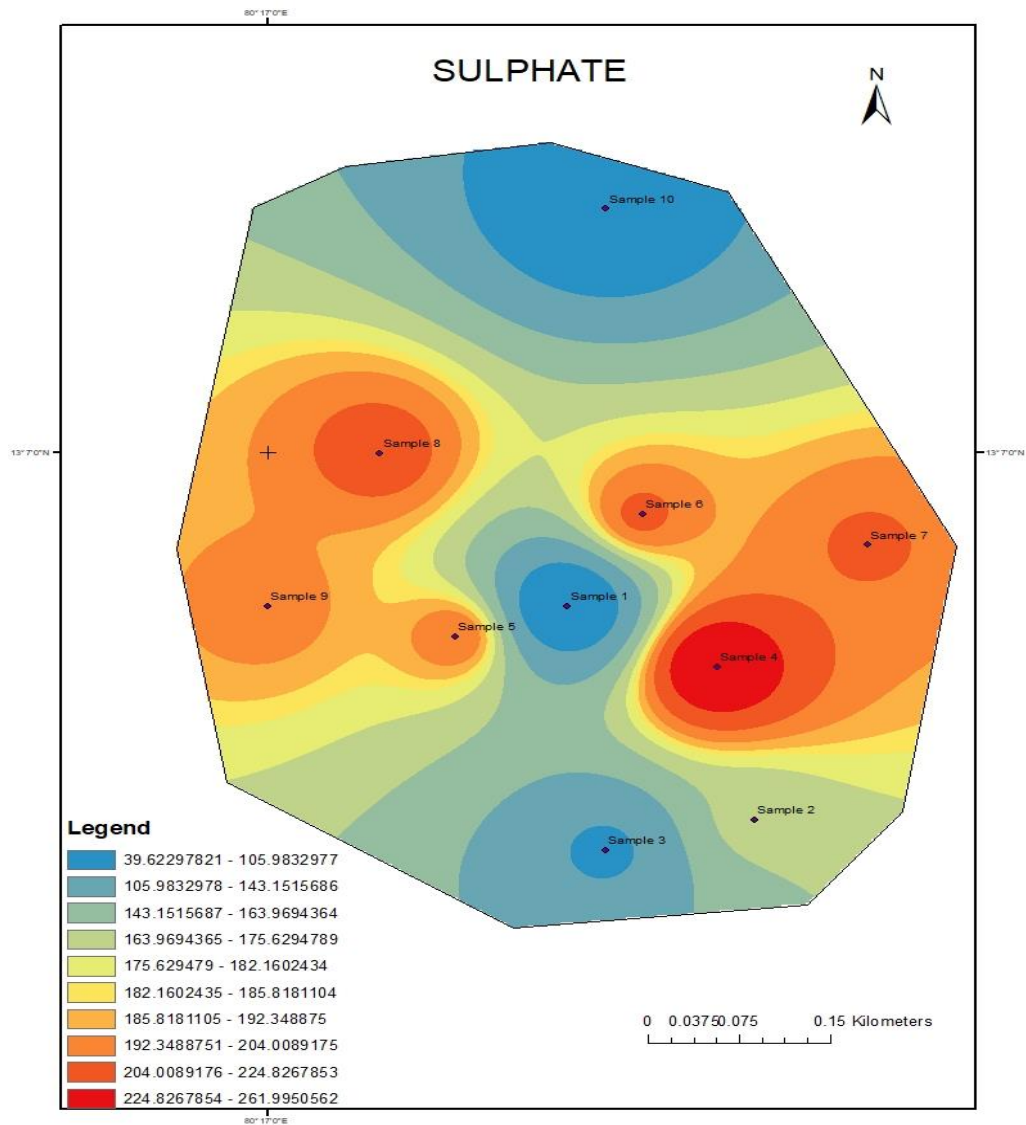


Fig: 5.14: Refers to spatial variation of Sulphate

Concentration of Iron

In this fig 5.15 and fig 5.16, it shows the spatial variation of Iron in the study area. Sample 1, sample 2, shows a higher concentration of Iron and sample 3, 6, 7&10 lower concentration of Iron value. The permissible limit of Iron is 0.3mg/l. Increase content of Iron in the water may cause ill effects.

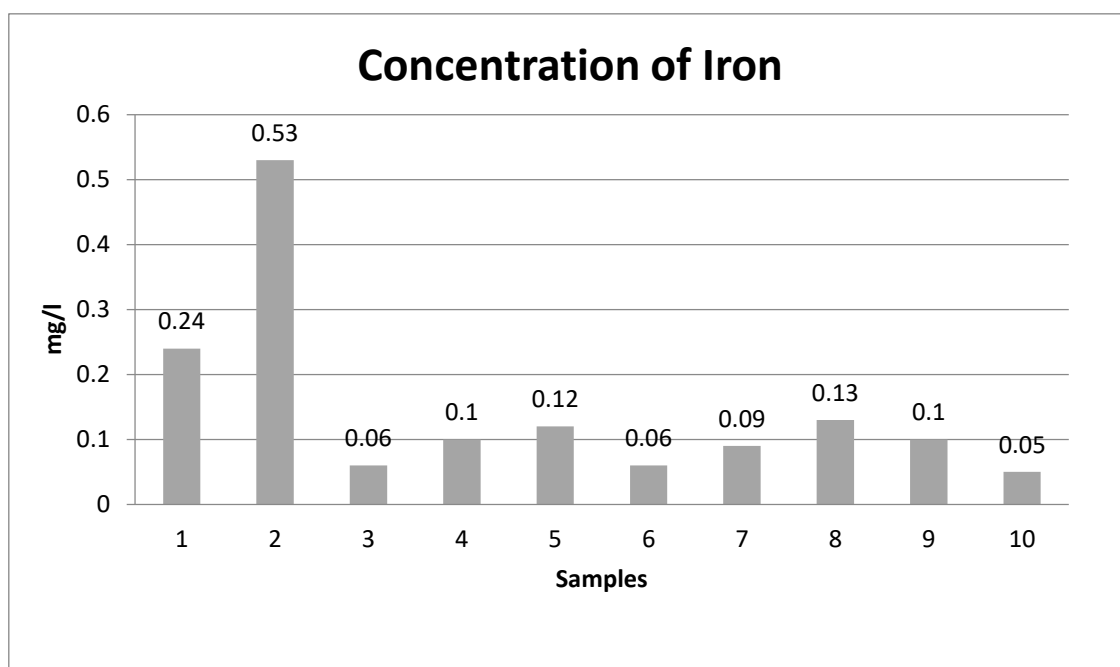


Fig: 5.15: Iron

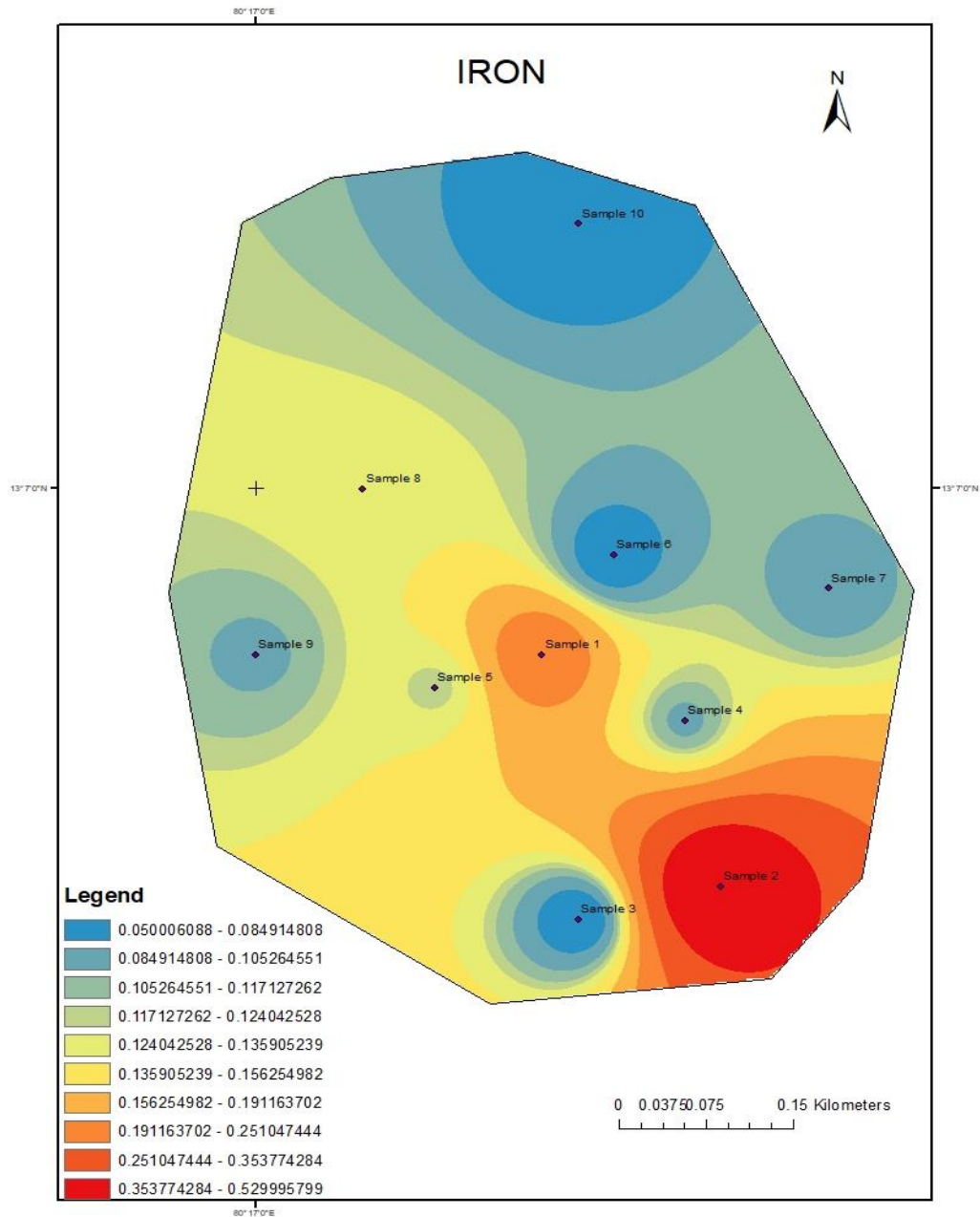


Fig: 5.16: Refers to spatial variation of Iron

Concentration of Manganese

The manganese of all the samples are within the permissible limit shows in Fig 5.17

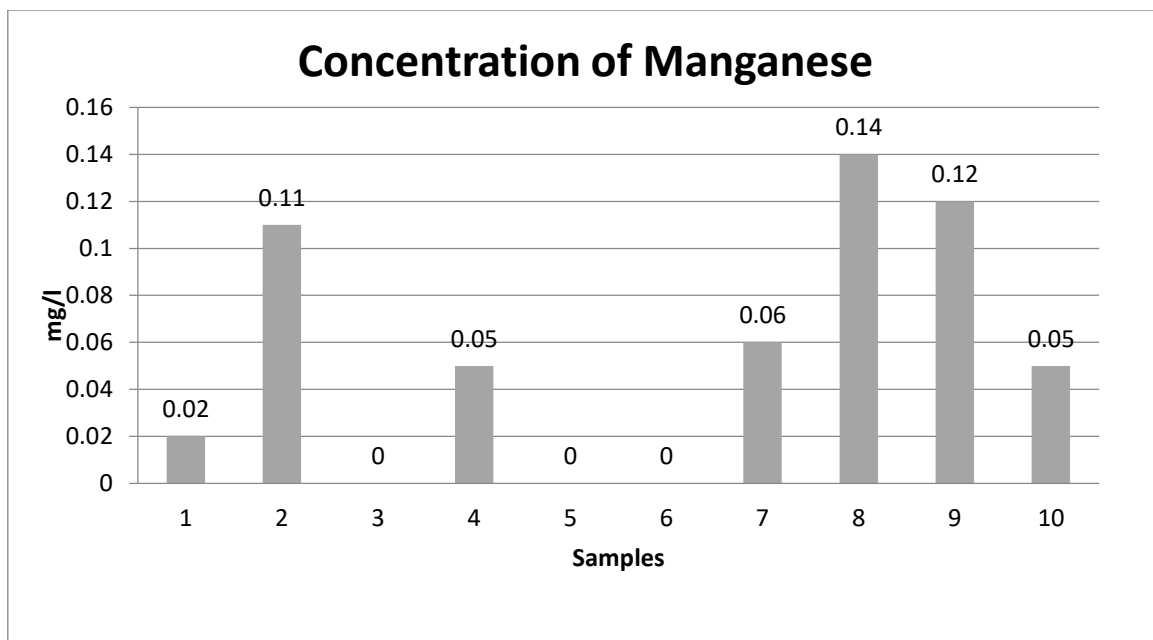


Fig: 5.17: Manganese

Concentration of Total Dissolved Solids

In this fig 5.18 and fig 5.19, it shows the spatial variation of TDS in the study area. Sample 4, 8 shows a higher concentration of TDS and sample 1 is a lower concentration value of TDS. The permissible limit of TDS is 500mg/l. Increase content of TDS in the water may cause ill effects.

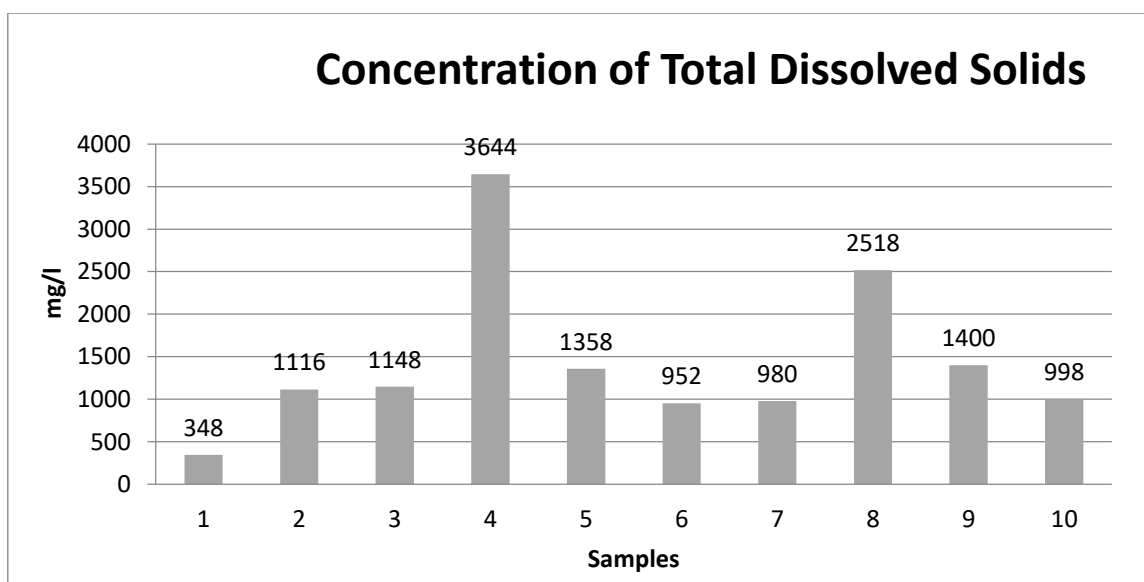


Fig: 5.18: Total Dissolved Solids

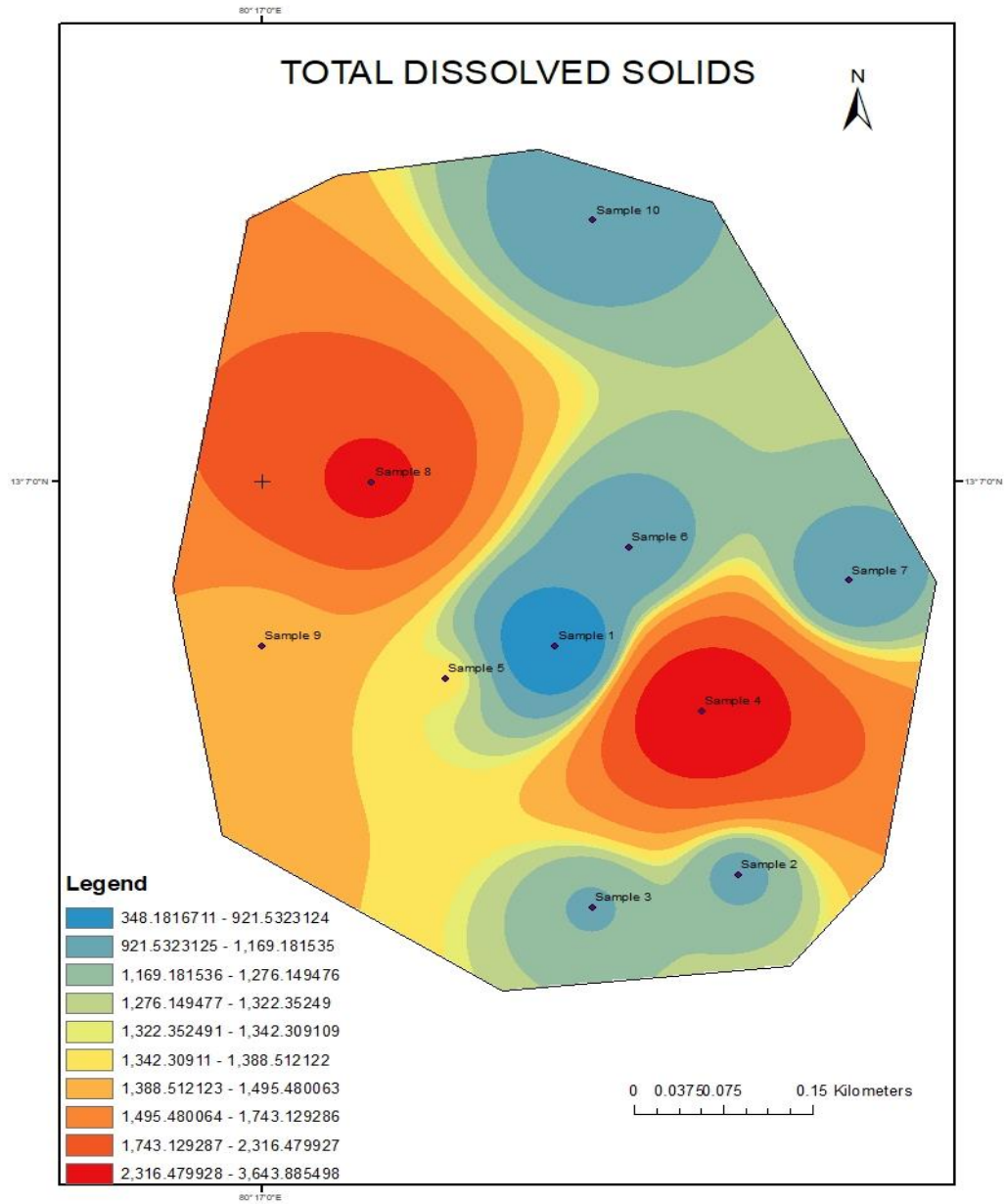


Fig: 5.19: Refers to spatial variation of TDS

CHAPTER 6

SUMMARY AND CONCLUSION

The analysis of the result shows that the parameters such as Calcium, Total hardness, Chloride, Manganese, Total dissolved solids, and Sulphate concentration of sample 4 were above the permissible limit by the Bureau of Indian Standards. The pH range of all the samples is within the permissible limit for all the samples and in most of the samples, the chloride concentration was more than the permissible limit. The test on heavy metal concentration on the collected sample shows that the presence of a small quantity of manganese and Iron in water all other heavy metal concentration was below detection level. Even though the concentration of all the parameters is within the permissible limit the concentration was more the acceptable levels given by the Bureau of Indian Standards. So, Necessary steps have to be taken to protect further contamination of groundwater and maintain the concentration of different parameters within the permissible limit.

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