ASSESSMENT OF GROUND WATER QUALITY USING WATER QUALITY INDEX WITHIN 4KM.THE RADIUS OF RAUZAGAON SUGAR MILL IN FAIZABAD DISTRICT

A Project Submitted
in Partial Fulfillment of the Requirements
for the Degree of

MASTER OF TECHNOLOGY

In

Environmental Engineering

By

WARIS ALI ANSARI

(University roll No.1180470003)

Under Guidance

of

Mr. KAMALNABH TRIPATHI

(Assistance Professor)

(DEPTT.OF CIVIL ENGINEERING)

BABU BANARASI DAS UNIVERSITY

LUCKNOW

Session:-2019-20

DECLARATION

We hereby declare that the project entitled **"ASSESSMENT OF GROUND WATER QUALITY USING WATER QUALITY INDEX WITHIN 4KM RADIUS OF RAUZA GAON SUGAR MILL IN FAIZABAD DISTRICT"** submitted by us in the fulfillment of the requirements of the for the award of the degree of **MATER of Technology in Environmental engineering,**to the Babu Banarasi Das University ,Lucknow,is record our own work carried under our supervision and guidance of **Mr. Kamal Nabh Tripathi** (assistant professor),of Department of Civil Engineering ,Babu Banarasi Das University, Lcknow, we further declare that the work reported in this project has not been submitted either in part or in full, for the award of any other degree or diploma in this University or any other institute or university.

WARIS ALI ANSARI

(1180470003)

CERTIFICATE

Certified that **WARIS ALI ANSARI (1180470003)** has carried out the research work presented in this Project entitled **"Assessment of Ground water Quality using Water Quality Index within 4km. the Radius of Rauzagaon Sugar Mill in Faizabad District"** for the award of **Masters of Technology in Civil Environmental Engineering** from Babu Banarasi Das University, Lucknow under my supervision. The Project embodies results of original work, and studies are carried out by the student himself and the contents of the Project do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

Signature

Mr.Kamalnabh Tripathi
(Project Guide)
Department of civil Engineering
Babu Banarasi Das University,
Lucknow

Date: 06/07/2020

ABSTRACT

Groundwater is a significant piece of the water cycle and it is essential wellspring of drinking water just as quality Farming purposes. The fast industrialization causing difficult issues concerning the appearance of groundwater degradation because of the release of treated or somewhat treated wastewater from industry Thus, it is important to evaluate the groundwater

This research investigates the effect of the sugar industry effluent on the quality of groundwater supported groundwater quality index. The sugar industry is the most significant agro-based production in India. A fundamentally enormous volume of waste is created during the production of sugar and contains a high measure of contamination load especially regarding suspended solids, organic matter, nitrate, phosphorous, press mud, and heavy metals like cadmium. This release of sugar industry passes through the soil which causes the degradation of groundwater as well as surface water and soil which besides people suffer from various health hazards. The general water quality status portrayed by the Water Quality Index (WQI) through which numerical score got from the coordination of complex water quality parameters.

In this paper effort has been made for the study of physico-chemical characteristics of sugar industry effluent, the outcome of the sugar industry effluent on groundwater quality, evaluating Water Quality Index for groundwater. For suitability of human consumption.

ACKNOWLEDGEMENT

We would like to express our gratitude to all the people behind the screen who helped us to transform an idea into a real application.

We owe immense intellectual debt to **Mr.Anupam Mehrotra,** head of Department of Civil engineering ,Babu banarasi Das university, lucknow who kindly concented to supervise the present project work and guided it to completion, for his invaluable help and guidance we express our deep sense of gratitude .

We would like to express our profound sense of deepest gratitude to our project guide and motivator **Mr.Kamal Nabh Tripathi** (assistance professor), Deprtment of Civil Engineering ,Babu Banarsi Das University ,Lucknow for her valuable guidance, sympathy and co-opration for providing necessary facilities and source during the entire priod of this project .

We wish to convey our sincere gratitude to all the faculties of Civil Engineering department who have enlightened us during our studies. The facilities and co-operation received from technical staff of civil Engineering Department is thankfully acknowledged.

We express our thanks to all those who helped us in one way or other .

The blessing our parents have been continuous source of encouragement for us throughout the project.

WARIS ALI ANSARI

(1180470003)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

UNEP	:	United Nations Environmental Programme
BIS	:	Bureau of Indian Standards
WHO	:	World Health Organisation
ICMR	:	Indian Council of Medical Research
NSFWQI	:	National Sanitation Foundation Water Quality Index
WQI	:	Water Quality Index
NPI	:	Nemerow's Pollution Index
TDS	:	Total Dissolved Solids
TH	:	Total Hardness
EC	:	Electrical Conductivity
SAR	:	Sodium Adsorption Ratio
RSC	:	Residual Sodium Carbonate
CSSRI	:	Central Soil Salinity Research Institute
GIS	:	Geographical Information Systems
RS	:	Remote Sensing
NRSA	:	National Remote Sensing Agency
GPS	:	Global Positioning System
IS	:	Indian Standard
K	:	Potassium
Meq/L	:	Milliequivalents per Litre
Mg	:	Magnesium
Mg/L	:	Milligram per Litre

Mhos/cm	:	milliohms per centimetre
mm	:	millimetre
Na	:	Sodium
NEERI	:	National Environmental Engineering Research
$N0_3$	:	Nitrates
pH	:	Potenz Hydrogen ion
$S0_4$	:	Sulphate

CHAPTER 1

INTRODUCTION

1 General

Water is an essential natural source and an ideal necessity for sustenance of life. Water is not only the most important essential component of all animals, plants and other organisms, but it is also crucial for the survivability of mankind in the biosphere. According to the yearly report of Global maize and wheat improvement centre, in the global water resources, about 97.5% is saline water mainly in oceans and 2.5% is available as freshwater. Freshwater is a limited resource and is locked in icecaps and glaciers or lies in deep underground reservoirs [1]. The percentage of freshwater in rivers and lakes is very meagre. Most of the surface waters in India, including both rivers and lakes, are getting more polluted due to invasion of social exercises of diverse nature. The demand for water has increased over the years and this has led to water deficiency in many parts of the world. The situation is complicated by the problem of water pollution or contamination. India is heading towards a freshwater crisis mainly due to inappropriate management of water resources and environmental crisis is already visible in many parts of India, differing in scale and intensity [2]. It is approximated that nearly 70% of our water sources are polluted. The growing scales of cultural and technological development pose new threats to water quality. In India, there is a clear visible threat to the quality of water. The predicted water demand for the future is alarming.

Groundwater is the primary resources of water for human consumption as well as for agricultural and industrial uses in many regions all over the world. Due to the limited availability of surface water, groundwater remains the requirement of human activities. Groundwater remains the only option to supplement the ever-increasing demand for water. It is estimated that nearly one-third of the world's population use groundwater for drinking (UNEP, 1999). Groundwater contributes 0.6% of total water resources on Earth. It estimates for nearly 80% of the rural domestic water needs and 50% of the urban water Requirements in the developing countries in India. The quality of water resources is being increasingly degraded as an outcome of its enhanced anthropogenic exploitation. In developing countries like India, around 80% of diseases are directly related to poor drinking water quality and unhygienic situations. Groundwater contamination by different pollutants, natural geological formations and due to the accelerated agricultural and urban development has placed the whole environment at greater risk. Poor quality of water negatively affects human health and plant growth. Groundwater quality monitoring is a mechanism which provides important information about water management.

In this regard, the present study has been focused on quality assessment of groundwater of radius of sugar industry located Rauza gaon village in Faizabad district and its suitability for drinking and irrigation purposes. The details of this investigation are presented in various chapters of this volume

1.1 Importance of Water and Major Sources of Water

Water is one of the five elements of the universe. The origin and evolution of life on planet Earth are most intimately linked with water. Water is the most abundant and essential compound in all the living systems. Its amount of living organisms fluctuates between 60-99.7% by weight. It is an internal medium for all biochemical reactions. Water is a principal ingredient for photosynthesis. It is vital in food production- food of plant as well as of animal origin. Water is one of the five elements of the universe. In fact, the origin and evolution of life on planet Earth is most intimately linked with water. Water is the most abundant and essential compound in all the living systems. Its amount in living organisms fluctuates between 60-99.7% by weight. It is an internal medium for all bio-chemical reactions. Water is a principal ingredient for photosynthesis. It is vital in food production- food of plant as well as of animal origin.

The principle source of all water supplies is precipitation. Precipitation upon entering the ground infiltrates into the soil or moves across the surface as runoff. Surface runoff happens when rainfall intensity exceeds the rate of infiltration. Water runs along the surface as confined or unconfined flow or moves along the surface in broadsheets of water. Confined flow leads to water confined to channels.

Sub-surface water includes groundwater and soil water. Groundwater is the quantity of water below the surface of the ground caused by that portion of rainfall which penetrates through the soil pores and rock cracks, flows by gravity till it enters an impervious stratum while moving in a parallel orientation. The water beneath the surface can essentially be divided into three zones as soil water zone, intermediate zone, and groundwater zone. The top two zones are grouped as the zone of aeration. Below the zone of aeration lies the zone of saturation or groundwater zone. The water table separates the zone of aeration from the zone of saturation.

The chief sources of water are rainwater, seawater, groundwater and surface water. In India, the annual rainfall is about 400 million hectare meters (MHM). Out of this, 70 MHM of water evaporates immediately, 115 MHM runoff into surface water bodies and the remaining percolates into the soil.

Based on rainfall records and runoff coefficients, the total yearly flow through rivers in India is supposed to be around 168 MHM. The mass balance of seasonal rainfall shows that about 70% of water is lost by evaporation and transpiration by plants, while the remaining 30% goes into the stream flow. Data concerning groundwater resources, i.e., water collected from precipitation and stored in aquifers are more limited than those on the surface water resources. Net annual recharge in Indian is 67 MHM and out of this only 35 MHM is available for utilization. Combined with surface water, it gives the total utilizable potential of freshwater to be nearby 100 MHM.

HYDROLOGICAL CYCLE

The various earths' water-sources get their supplies from precipitation, while the precipitation in itself is the evaporation from these sources. Water is lost to the atmosphere as Vapour from the earth, which is then precipitated back in the form of rain, snow, hail, dew sleet or frost, etc. This precipitation and evaporation continues for ever, and thereby a balance is maintained between the two. This process is known as hydrologic cycle and is shown in Fig.1.1.

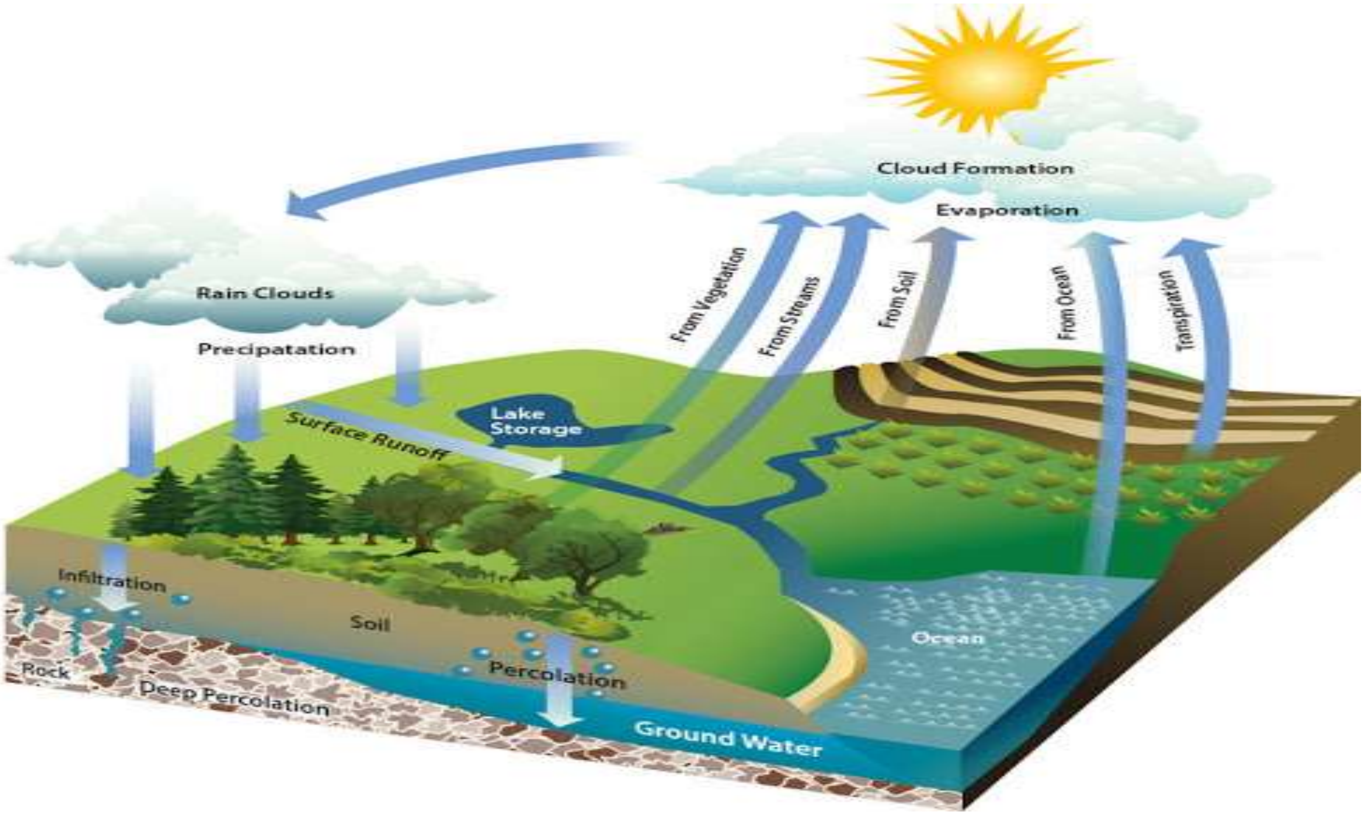

Fig.1.1 Hydrological cycle

1.1.1 Surface Water Sources

They include (a) Rivers, (b) Lakes and,(c) Reservoirs. A river is a stream of running fresh water. A lake is defined as a large inland depression filled with water. A reservoir is an artificial lake created by the construction of a dam across a river.

1.1.2 Groundwater Sources

(a) Wells, (b) Springs, and(c) Infiltration Galleries

Wells have been classified as shallow wells and deep wells. A shallow well catches the water from the area above the first impervious layer. Deep wells trap the water from the area below the first impervious layer. Yield from a deep well is normally constant and will be of considerable quantity while shallow wells usually go dry in the summertime.

1.2 Water Pollution

"Water is God's creation and Pollution is man's contribution"

Water is one of the five elements explained in "shastra" to life. Water is one of the most important assets which Man has utilised than any other resource for the sustenance of his life. Pollution is the change in the physical, chemical, radiological or biological quality of the resource (air, land, water) caused by man or due to man's activities that is injurious to living, intended or potential uses of the resources. The quality of water depends upon the place and state of environmental protection in a given area [3].Pollution is defined as any degradation of natural water quality due to:

1. Contamination

2. Addition of solid, liquid or a gaseous waste

3. Addition of physical, chemical or biological agents

4. Addition of sewage or industrial effluents

As a result of the above activities, the water quite often becomes unfit for different uses such as drinking, domestic purposes, irrigation, industrial purposes etc.

1.2.1 Surface Water Pollution

Surface Water bodies usually get polluted through surface run-off that carries along with its organic and inorganic impurities mainly suspended pollutants. They are also polluted due to the release of sewage or industrial effluents. Agricultural run-off pollutes surface water bodies by the addition of nutrients, pesticides and salinity.

1.2.2 Groundwater Pollution

Groundwater pollution may be defined as an artificially produced degradation of natural groundwater quality [4]. Most pollution introduces from the disposal of wastewater following the use of water for a wide variety of purposes. A large number of sources and causes can modify groundwater quality, ranging from septic tanks to irrigated agriculture apart from domestic and industrial wastes. The principal sources of groundwater pollution are classified into four categories.

(a) Municipal (b) Industrial (c) Agricultural (d) Miscellaneous

(a) Municipal Sources and causes

Sewer Leakage: Sewer leakage can enter high concentrations of BOD, COD, Nitrate, Organic chemicals and probably bacteria into groundwater. Sewers located in industrial areas offer pollution through heavy metals such are arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese and mercury.

(b) Industrial sources and causes

Liquid wastes: Groundwater pollution can occur where industrial wastewaters are discharged into pits, ponds or lagoons thereby enabling the wastes to migrate down to the water table.

Tank and Pipe line leakage: Underground storage and transmission of a wide variety of fuels and chemicals are common practices for industrial and commercial installations. These tanks and pipelines are susceptible to structural failures leading to subsequent leakage which becomes a source of groundwater pollution.

Mining Activities: Mines can produce a variety of groundwater pollution problems. Pollution depends on the material being extracted and the mining process. Coal, phosphate and uranium mines are major contributors. Metallic ores for production of iron, copper, zinc and lead are also important.

Oil field brines: The production of oil and gas is usually accompanied by substantial discharges of wastewater in the form of brine. Constituents of brine include sodium, calcium, ammonia, boron, chloride, sulfate, trace metals and high total dissolved solids.

(c) Agricultural sources and causes

Irrigation return flow: Approximately one half to two thirds of the water applied for irrigation of crops is consumed by evapotranspiration and the remainder, termed irrigation return flow, drains to surface channels or joins the underlying groundwater.

Fertilizers and Soil amendments: When fertilizers are applied to agricultural land, a portion usually leaches through the soil to reach the water table. Soil amendments are applied to irrigated lands to alter the physical or chemical properties of the soil. Lime, gypsum and sulfur are widely used for this purpose. Substantial amounts of these soil amendments may eventually leach to the groundwater, thereby increasing its salinity.

Pesticides: Pesticides can be significant in agricultural areas as a diffuse source of groundwater pollution. The presence of these materials in groundwater, even in minute concentrations, can have serious consequences in relation to the portability of the water.

(d) Miscellaneous sources and causes

Saline water Intrusion: Salinity is the most common pollutant in groundwater near coastal areas. Intrusion of saline waters occurs where it displaces or mixes with fresh water in an aquifer. The phenomenon can occur in deep aquifers with the upward advance of saline waters of geologic origin, in case of shallow aquifers the same can take place from surface water discharges while in coastal aquifers the process is through an invasion of sea water

Septic tanks and Cesspools: The most numerous and widely distributed potential source of groundwater pollution are septic tanks and cesspools. Domestic sewage adds minerals to groundwater. Bacteria and virus are normally removed by the soil system. Phosphorous is generally retained by the soil, but significant quantities of nitrogen can be added to groundwater.

Spills and Surface discharges: Liquids discharged on to the ground surface in an uncontrolled manner can migrate downward to degrade groundwater quality. At industrial sites casual activities may include losses during transfer of liquids, leaks from pipes and valves and inadequate control of wastes and storm runoff.

1.2.3 Pollution in Water

Water is essential for the survival of any form of life. It is one of the most important commodities which has exploited much more than any other resource for sustenance of his life. Injudicious and uncontrolled explorations of water bring the change in the physical, chemical, biological quality of the water due to that water becomes unfit for drinking and other domestic uses. Human activities can change the natural composition of ground water through the disposal of chemicals and microbial matter at the land surface and into soils, or through injection of wastes directly into ground water and water get polluted.

Water pollution is mainly caused by natural processes and anthropogenic processes. Water pollution can be classified into four categories viz., physical, chemical, biological and physiological pollution of water.

Physical Pollution of Water

It brings about changes in water with regard to its colour, odour, density, taste, turbidity and thermal properties etc.

Colour-Colour change may affect the penetration of sunlight inhibiting plant and animal metabolism.

Turbidity-Turbidity in water mainly arises from colloidal matter, fine suspended particles and soil erosion.

Taste and Odour-Unpleasant earthy or musty taste and odour are produced by industrial Effluents containing Fe, Mn, free chlorine, phenols and aquatic actionomycetes**.**

Chemical Pollution of Water

The chemical pollution of water causes changes in acidity, alkalinity or pH and dissolved oxygen. It may be caused either by organic pollutants or inorganic pollutants or by both. The organic pollutants can be biodegradable or non-biodegradable.

Biological Pollution of Water

Bacterial pollution in water is caused by the excretory products of man, animals and birds. The main pollutants belong to coliform group and certain subgroups, faecal streptococci and miscellaneous organisms. Biological pollution is also brought about by bacteria, viruses, algae, diatoms like protozoa, rotifers, crustaceans and plant toxins.

1.3 GROUND WATER

Groundwater part of the earth's water cycle that flows underground occurs in many different geological formations, Water in the saturated zone is called Groundwater. It caters to 80% of the total drinking water requirement and 50% of the agricultural requirement in rural India (Meenakshi & Maheshwari, 2006) [5].

Annually, whatever quantity of water received as rainfall from a large quantity of water soaks and infiltrates in to the ground and follows the path of least resistant through air pockets between soil and rock particles. Ground water is all the water below the water table stored in subsurface void spaces.

It is estimated that approximately one-third of the world's population use groundwater for drinking. Ground water is recharged from rain water and snowmelt or from water that leaks through the bottom of lakes and rivers (UNEP, 1999) [6].

1.3.1 GROUND WATER QUALITY

Water quality expresses the suitability of water for various uses and processes and it comprises the physical, chemical and biological qualities and the quality can be described in terms of concentration and state of some or all of the organic or inorganic material present in the water, together with certain physical characteristics of the water.

Groundwater in its natural state is generally of good quality because rocks and their derivatives such as soils act as filters. However, the natural waters are not pure and contain some amounts of dissolved gases, solids, and suspended materials (Fetter, 1994) [7].

The quality of groundwater depends on the composition of the recharged water, the interactions between the water and the soil, dissolved gases, geological conditions, the residence time and reactions that take place within the aquifer. Therefore, considerable variations may be found, hence it is necessary to monitor all aspects related to provision Of suitable quality of water for various purposes and a special attention needs to be made on identifying various physical, chemical, bacteriological and radiological parameters influencing water quality and for proper monitoring of parameters it is needed to set up appropriate mechanisms from top to bottom level in country.

The characteristics temperature, colour, odour, taste and electrical conductance determine the physical quality, most of the ground waters are colorless, odorless and without specific taste. The chemical composition is derived mainly from the dissolution of minerals in the soil and rocks with which it is or has been in contact. And the chemical characteristics depends on interaction with solid phases, residence time of groundwater, seepage of polluted runoff water, mixing of groundwater with pockets of saline water and anthropogenic impacts (Umar et al., 2006)[8]. The type and extent of chemical contamination of the groundwater is largely dependent on the geochemistry of the soil through which the water flows prior to reaching the Aquifers (Zuane, 1990) [9].

As water flows through the ground the dissolution of minerals continues and the concentration of dissolved constituents tends to increase with the length of the flow path. At great depths, where the rate of flow is extremely slow, groundwater is saline, with concentrations ranging up to ten times the salinity of the sea. Groundwater can become unpotable if it becomes polluted and is no longer safe to drink. In areas where the material above the aquifer is permeable, pollutants can seep into groundwater.

Groundwater is more mineralized in alluvial aquifers than in the weathered basement aquifers (Kundell, 2008)[10]. The importance of drinking water quality has been enhanced in the last few years by the increased awareness and attendant publicity afforded to the pollution of water courses. Globally, the UN declared an International Drinking water supply and Sanitation Decade between 1981 and 1991.

The physical and chemical quality of water is important as the portability of the water and its fitness for domestic purposes largely depend on its chemical quality (Tiwari & Ali, 1988)[11]. In view of the wide, variations in the chemical quality of water available in different parts of the world or country, rigid limits cannot be laid down with regard to chemical constituents. Certain chemical substances, which may be present in natural waters, are toxic to human beings. It is expected that a great majority of water quality problems are related to bacteriological contamination, a significant number of very serious problems may occurs a result of chemical contamination of water sources from agricultural practices and malpractices (Mawulikwame, 2011)[12].

Chemical and physical constituents should not be permitted in drinking water in excess of the permissible concentration. Certain other parameters that render the water unpalatable and unfit for domestic use should have limits such as a maximum permissible limit. The suitability of water for drinking purposes with regard to its chemical and physical quality has, therefore, to be determined on the basis of general characteristics of the water available in the locality, and its freedom from toxic substances.

1.4 WATER QUALITY STANDARDS

The chemical composition of surface and groundwater is depend on chemical nature of earth's crust and the distribution of rock types and chemical nature of water is also influenced by the composition of rain and human activities such as disposal of industrial and municipal wastes.

The rapid industrialization, urbanization and increasing load of population, uncontrolled and unjudicious exploration of water and pollution is affecting the quality of groundwater. Therefore to check the growth of water pollution, decide suitability for drinking and domestic purposes and also for comparative study purposes, standards have been established for inland surface waters and drinking waters. These standards are primarily guidelines that ensure that the physical, chemical and biological compositions of water are well within the limits and consumption of water not to cause any undesirable effects on living beings especially human health.

Various institutions, associations, organizations and health agencies have proposed the standards at international level for acceptable potable water such as American Public Health Association (APHA), World Health Organization (WHO), Indian Council of Medical Research (ICMR), and Bureau of Indian Standards (BIS).

Table: 1.1 BIS Drinking Water Standard (IS: 10500-2012) [13]

Parameter	Acceptable limits	Permissible limits
Colour	5	15
Odour	Agreeable	Agreeable
taste	Unobjectionable	Unobjectionable
pH	6.5-8.5	No Relaxation
Temperature	NG	NG
Turbidity	1	5
EC	1500	3000
TDS	500	2000
Fluoride	1	1.5
Chloride	250	1000
Sulphate	200	400
Nitrate	45	No
Total Alkalinity	200	600
Total Hardness	200	600
Magnesium	30	100
Calcium	75	200
Sodium	NG	NG
Potassium	NG	NG
Iron	0.3	1
Zink	5	15
Cadmium	0.003	0.01
Copper	0.05	1.5
Arsenic	0.01	0.05
lead	0.05	No Relaxation
DO	NG	NG
BOD	NG	NG
COD	NG	NG
Carbonate	NG	NG
Bicarbonate	500	NG

NG = Not Given

Table:1.2 WHO and ICMR Drinking Water Standard (ICMR, 1975; WHO, 2008) [14]-[15]

Parameter		WHO	ICMR
pH	Desirable Limit	7 – 8.5	7 – 8.5
	Max. per limit	6.5 – 9.2	6.5 – 9.2
Fluoride	Desirable Limit	0.7	1
	Max. per limit	1.5	1.5
TDS	Desirable Limit	500	500
	Max. per limit	1500	1500
Chlorides	Desirable Limit	200	200
	Max. per limit	600	1000
Niterate	Desirable Limit	45	20
	Max. per limit	-	50
Turbidity	Desirable Limit	5 NTU	5 NTU

	Max. per limit	25 NTU	25 NTU
Sulphate	Desirable Limit	200	200
	Max. per limit	400	400
Sodium	Desirable Limit	200	-
	Max. per limit	250	-
Calcium	Desirable Limit	75	75
	Max. per limit	200	200
Magnesium	Desirable Limit	30	50
	Max. per limit	150	150
Total Hardness	Desirable Limit	300	300
	Max. per limit	500	600
Potassium	Desirable Limit	10	-
	Max. per limit	-	-
Bicarbonate	Desirable Limit	500	500
	Max. per limit	-	-
Arsenic	Desirable Limit	0.01	0.05
	Max. per limit	NR	NR
Iron	Desirable Limit	0.3	0.1
	Max. per limit	1	1

One of the recent WHO guidelines for drinking water quality contains a comprehensive list of recommendations with health criteria and supporting information which are not intended to serve as standards by themselves; instead, they provide a basis on which individual countries can develop their own standards or regulations in the context of appropriate environmental, social, economic and cultural conditions. Therefore, national standards may be considerably different from the international guidelines. In India drinking water standards are issued time to time by the Bureau of Indian Standards (BIS) and the Indian Council for Medical Research (ICMR) other agencies. The water quality standard issued at international and national are shown in table 1.1 and 1.2.

1.4.1 Water quality parameter

Natural parameters (temperature and discharge), the inorganic parameter (total solids) and organic nutrients (nitrate) are the most significant parameters which contribute to water quality variations for all seasons [16].

Physical parameters of water: The physical characteristic of water includes turbidity, color, taste, odour and temperature.

Turbidity: Suspension of particles in water intrusive with passage of light is called turbidity. Turbidity is caused by wide variety of Suspended particles. Turbidity can be meas-ured either by its impact on the transmission of light which is named as Turbiditymetry or by its impact on the diffusing of light which is termed as Nephelometry. As per IS: 10500-2012 the acceptable and passable limits are 1 and 5 NTU respectively.

Color: Dissolved organic material from decaying vegetation, presence of minerals, inorganic chemicals and metals (e.g. iron and manganese) cause color in water[17]. Color itself is not usually objectionable from a health standpoint but its presence is aesthetically objectionable and suggested that the water needs appropriate treatment.

Taste and odour: Taste and odor in water can be caused by foreign matter such as inorganic compounds, organics or dissolved gases which may come through agricultural, domestic additions or natural sources [17]. Water should be free from any objectionable taste or odor at the point of use.

Temperature: The temperature of water has extremely important ecological consequences. Temperature is basically important for the chemical and biological reactions of organisms in water. The increase in temperature decreases the potability of water because at elevated temperature carbon di oxide and other volatile gases which impart taste are expelled [18].

Chemical parameter: The chemical characteristics of water include natural substances such as dissolved minerals, manmade toxic metals and organic chemicals. Some chemical parameters are:

pH: It is the measure of hydrogen ion concentration for many practical practices. Neutral water pH-7 Acidic water has pH below 7 Basic water has pH above 7 Desirable limit 6.5-8.5 ,Beyond this limit the water will affect the mucous membrane and water supply system.

Total dissolved solids: Total dissolved solids is the total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water. It is expressed in mg/L and parts per million. Total dissolved solids concentration is the sum of the cations and anions in the water. An important aspect of TDS with respect to drinking water quality is the affect on test1[19]. High concentrations of TDS in water reduce water clarity; decrease the rate of photosynthesis, and join with toxic compounds and heavy metals[20].

Amount of TDS in the water depends on where the water comes from i.e. water that passes through soils in high in soluble salts or minerals have higher TDS levels. Higher TDS also occur from natural sources, sewage, urban and agricultural runoff and industrial waste water, salts used for road deicing[21].

Nitrate: Most common contaminant in the ground water is dissolved nitrogen in the form of nitrate because of its high water solubility[22]. Nitrogen in municipal waste water results from human excreta, ground garbages, and industrial waste, particularly from food processing. Greatest source of nitrogen in waste water is from human fecal matter. Nitrate is usually introduced into ground water through non point sources like leaching of chemical fertilizer, leaching of animal manure, from septic and sewage discharges etc.

In agricultural regions, groundwater can have significant concentrations of nitrate from unused fertilizer leaching into the underlying aquifers. Porous soil profile permits rainfall and irrigation water to transport this high – nitrate pore water to the groundwater table without measurable denitrification loss. Nitrate is the end product of aerobic stabilization of organic nitrogen and a product of conversion of nitrogenous material, and as such occurs in polluted water[23]. It can be removed by demineralizing water or by distilling it. Nitrite and nitrate in nature are determined by colorimetric method. Ammonia, nitrate, nitrite and gaseous nitrogen and organic nitrogen are common forms of nitrogen. Nitrogenous organic matter is decomposed and releases ammonia to solution. Under aerobic conditions, nitrifying bacteria oxidize ammonia to nitrite and then to nitrate [24].

$NH_3 + O_2 \rightarrow NO_2^- + energy$ ………………………………………………………...… (5)

$NO_2^- + O_2 \rightarrow NO_3^- + energy$ ……… …………………………………………………… (6)

Fluoride: Fluoride mainly occurs in ground water through fluoride bearing minerals in the hot rock, such as fluorite (CaF2), fluorapatite Ca5F(PO4)3, apatite Ca5(PO4)3, due to chemical properties like decomposition, dissolution and their interaction with water[25]. Other causes of fluoride in water come from runoff and infiltration of chemical fertilizers in agricultural areas, septic and sewage treatment system which discharges in communities with fluoridated water supplies and liquid waste from industrial sources.

Fluoride enters the body through various ways like food, water, industrial exposure, drugs, cosmetics etc. in which drinking water is the major contributor [26]. Trace amount of fluoride in the diet are important to the development of strong bones and teeth but too much fluoride has detrimental effect on human health [27].

Electrical conductance: Conductivity is the capacity of water to carry an electrical current and changes both with number and types of Ions the solution contains. In differentiate; the conductivity of distilled water is less than 1umhos/cm. This conductivity depends on the presence of Ion and their concentration, mobility, valence and relative concentration and on the temperature of the fluid .solution of most inorganic acids, bases, and salts are generally great conductors.

Hardness: Water hardness is the measure of the capacity of water to react with soap and derived from the solution of CO2, released by bacterial action in water containing soil, in percolating rain water and rock formation. Hard water is because of thick topsoil and contains minerals and metals constituents which dissolve limestone formations. Soft water is present where soil is sandy and the topsoil layer is thin and limestone is sparse or absent[28]. Hardness of water is of two types namely:

(i) Permanent hardness

(ii) Temporary hardness

Permanent hardness is caused by chlorides and sulphates of calcium, magnesium and transition metals. Temporary hardness is caused by bicarbonates, carbonates of calcium and magnesium. Permanent hardness is not destroyed by boiling and needs special treatment to remove it.

Hardness is due to dissolution of alkaline earth metal salts from geological matter [29]. Hardness of drinking water is a problem found in both ground & surface water. There is evidence that death rates from cardiovascular disease are inversely correlated with the hardness of water[30].

Chloride: All type of common and raw water contains chlorides. It comes from exercises carried out in agricultural area, Industrial releases and from chloride stones. Its con-centration is high because of human exercises. As per IS: 10500-2012 Acceptable limit for chloride is 250 and 1000 mg/l in Permissible limit

Sulphate: common water contains sulphate ions and most of these ions are also dissolved in water. Numerous sulphate ions are Produce by oxidation process of their metals, they also present in Industrial wastes. The procedure to measure quantity of sulphate is By UV Spectrophotometer. As per IS: 10500-2012 Desirable Limit and Permissible limit for Sulphate is 200 and 400 mg/l in respectively

1.4.2 Health Effect on Human Being

Toxicity is the inherent ability to impair health. Toxicity is of two types one is acute and another is chronic. Acute toxicity refers to a contaminant's ability to cause immediately detectable health problems and is: diarrhea, nausea, convulsions, blurred vision, and difficulty in breathing. Chronic toxicity refers to a contaminant's ability to cause health problems years after a long-term exposure. Some contaminants cause no detectable health problems at low doses but can cause death at high doses. Toxicity is not known to human by different intake and by acceptable daily intake to combatthe risk. Amount that includes a margin of safety represents the quantity of a contaminant or toxic substance that humans can in principle consume daily for a lifetime without any known ill effects62.

Table- 1.3 Chemical and contaminants in ground water

Substance	**Potential health and other effects**
Ph	High p^H causes a bitter taste, Low-pH water will corrode or dissolve metals and other substances
Chloride (Cl^-)	Deteriorates plumbing, Portability
Fluoride (F^-)	dental fluorosis (molting of teeth), Skeletal fluorosis
Nitrite (combined nitrate/nitrite)	Blue baby disease, or methemoglobinemia, which threatens oxygen-carrying capacity of the blood.
Sulphate (SO_4^{2-})	Portability
Hardness	Capacity of water for reducing and destroying the lather of soap
Calcium and Magnesium (Ca^{2+}, Mg^{2+})	Encrustation
Iron(Fe^{+2},Fe^{+3})	Encrustation, brownish color to laundered clothing and plumbing fixtures.
Silica (SiO_2)	Encrustation
Manganese (Mn^{-2})	Encrustation, brownish color to laundered clothing and plumbing fixtures.
Chromium (VI)	Chromium VI is much more harmful than Chromium III and causes liver and kidney harm, inside hemorrhaging, respiratory harm, dermatitis, and ulcers on the skin at high concentrations.

1.5 Water Quality Index

Accurate and timely information on quality of water is essential to shape a sound public policy for interest of health and to implement the water quality improvement programme effectively. There are a number of methods to analyze water quality data that vary depending on informational goal, the type of samples, and the size of the sampling area. One of the most effective ways to communicate information on the water quality trends is with indices as certain health related parameters [31].

Water Quality Index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers[32]. It is a important parameter for the assessment and management of ground water. It is defined as a rating reflecting the composite influence of different water quality parameters.

The WQI method for ground water quality assessment is widely used around the world due to the capability of fully expression of the water quality information [33]. The main objective of WQI is to turn complex water quality data into information that is understandable and useable by the public [34]. These include drinking, irrigation, recreation and livestock watering where such uses are naturally sustainable, and suitable for fish and wildlife.

A Water Quality Index is a numeric expression used to transform large number of variables data into a single number as index [35]-[36]. at different times and in different places, which represents the water quality level[37] and to translate this information into a single value defining the period of time and spatial unit involved and to be easily understood by managers[38]. Water Quality Index depends upon normalizing, data parameter according to expected concentrations and interpretation of good versus bad concentration. Then parameters are weighted according to their perceived importance to overall water quality and the index is calculated as the weighted average of all observations of interest [39].

The index is based on the attainment of water quality objectives. Quality objectives are for safe limits, set by the ministry in areas of human areas, to protect the most sensitive water uses of water resources. Water index defines a systematic way of interpretation and measurements of water quality naturally or desirables.

The index of water quality into five categories: excellent, good, fair, borderline, and poor. Every area describes the state of water quality with objectives usually represent the natural state including water quality requisites.

1.5.1 WQI as tool for quality of water

Water Quality Indices are aggregating and communicating tools to monitoring the water quality [40]. Water Quality Index can be used to assess water quality for general beneficial uses [41]. A single WQI value makes information more easily and rapidly understood than a long list of numerical values for a large variety of parameters [42].

A Water Quality Index can provide a way to summarize overall water quality conditions in a manner that can be communicated to a general audience. An index can tell us whether the overall quality of water bodies posses a potential threat to various uses of water. Index is used as a broad tool and indicates success in protection and remediation efforts. It is used to compare a water supply quality with other water supplies in the region or from around the world [43]-[42].

1.5.2 Classification of WQI

Water Quality Indices can be broadly classified into objective and subjective types[39]. Objective indices are those which do not make use of any subjective inference and are based on the expert opinion, questionnaires, etc. These are called the statistical indices. Subjective indices need two important specification such as weights (values according to importance of water quality parameters) and rating functions and are drawn out of questionnaire analysis inquiring the opinion of the experts. Unlike the objective indices, the subjective indices have some causal basis for representing the multivariate (consisting of more than one water quality parameter) data.

According to parameter the indices are broadly characterized into two parts:

(i) Physico – chemical indices and

(ii) Biological indices

The physico-chemical indices are based on the values of various physico chemical parameters in a water sample, while biological indices are derived from the biological information and are calculated using the species composition of the sample,the diversity of species, their distribution pattern, the presence or absence of the indicator species or groups. All indexing systems require measurements to be made for a selection of water quality determinants from these measurements, a sub –index rating values are then aggregated to produce the final index score.

1.5.3 Optimization of WQI.

Many methods were used for calculating Water Quality Index. Some are given below:

(i) Arithmetic water quality index

(ii) Multiplicative water quality index

(iii) Un-Weighted arithmetic water quality index

(iv) Un –weighted multiplicative water quality index

(V) Harkin's water quality index

(vi) Delphi approach for water quality index

(vii) The British Columbia index

Water Quality Index is an index originally proposed Horton (1965). Many researchers (Brown et al 1970, Dinius 1972) have used this index in their research work126, which is basically the weighted arithmetic mean in the following form.

$$WQI = \sum_{i=1}^{n} Wi\ qi$$

Where n is the number of variables, Wi is the relative weight of the ith parameter and qi is the quality rating of ith parameter.

The index was tested using historical data which are collected over several years to check the attainment of water quality objectives in the area. Model defines known factors that affect water quality and empirical relations derived from data testing for water management of city /area of territory.

1.5.4 Limitations of a Water Quality Index

Water Quality Indices by correlation contain less information than the raw data that they summarize. An index is not a complex predictive model for technical and scientific application. Distortion can occur from combining various environmental variables which are not taken for study into one single value or index score.

1.6 Study Area

The present study was aimed to assess Ground water quality in the localities of nearby the radius of Rauzagaon village sugar mill the study area located in Rudauli Tehsil in faizabad District of Uttar Pradesh India

Fig. 1.1 map of India and Faizabad (Google source)

Satellite map of study area

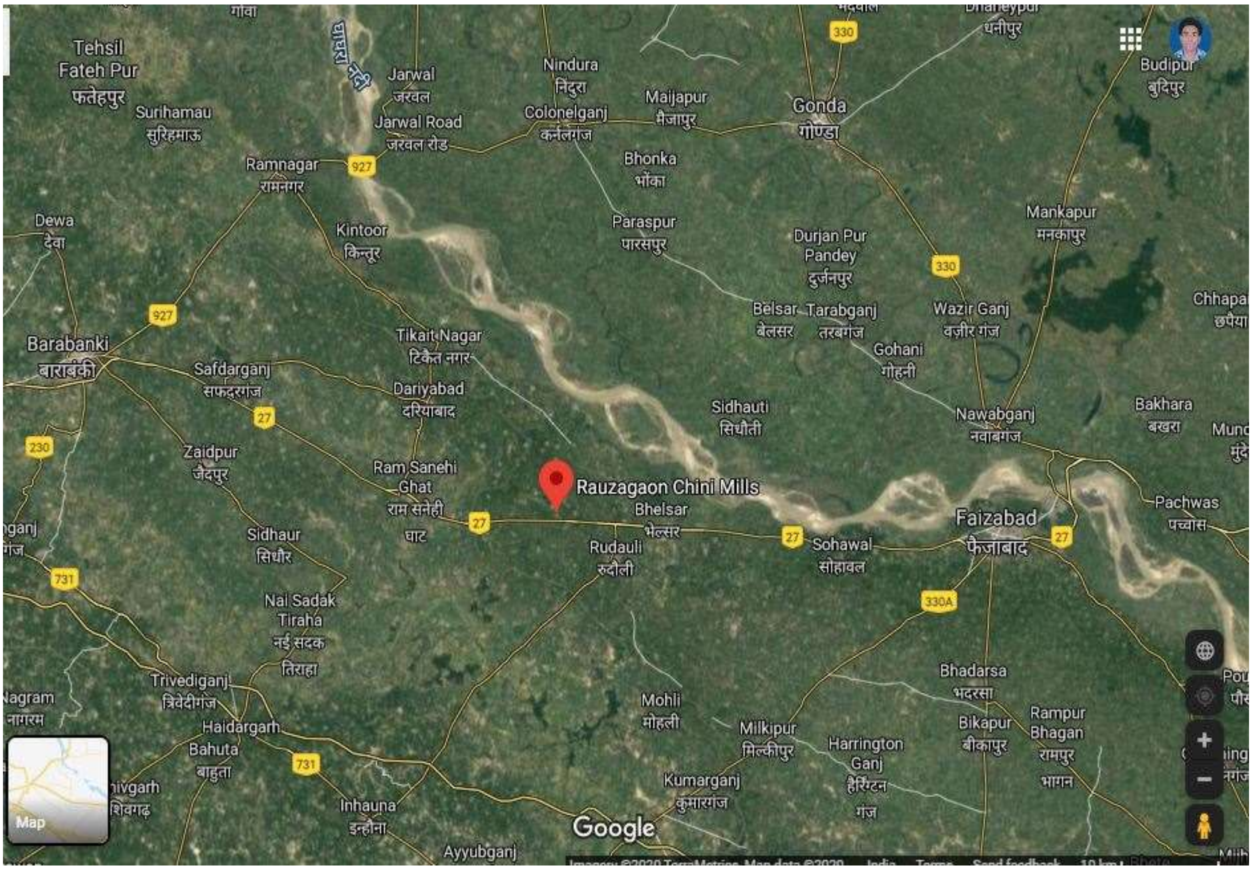

Fig. 1.3 satellite map of study area from (google source)

Faizabad is a city in the Indian state of Uttar Pradesh, which forms a municipal corporation with Ayodhya. It was the headquarters of Faizabad district and Faizabad division until 6 November 2018, when the Uttar Pradesh cabinet headed by chief minister Yogi Adityanath approved the renaming of Faizabad district as Ayodhya, and the shifting of the administrative headquarters of the district to Ayodhya city Faizabad is situated on the banks of river Ghaghra (locally known as Saryu) about 130 km east of state capital Lucknow. (26° 46′ 22.8″ N, 82° 8′ 45.6″ E) The study site map shown from figure

1.6.1 IMPORTANCE OF THIS STUDY

Groundwater is the major source of drinking and irrigational water for many rural and small communities. During recent years at global level, much attention has been paid to the chemical composition of groundwater in rural areas because it revealed that there is possibility of causal link between the geochemical environment and the groundwater quality. Rural areas may also pose major groundwater contamination problems by irrigation and subsurface geological formations.

The three main reasons for studying the distribution of geochemical constituents in the groundwater of the study area are:

- The lithology can become a source of chemical constituents to the groundwater column, so that the rock geochemistry data can be used to uncover the pollution history of an aquatic system, because they are more widely available, and more reliable.
- The fraction of chemical constituents accumulated in the drinking water should be identified to save people from water-borne diseases and the irrigation water should be analyzed to improve agriculture
- Agriculture is the main occupation of the people in the study area. The area is mostly covered with agricultural land and there may be a causal link between the groundwater contamination and irrigational activities. This concern has been addressed in this study.

1.6.2 Study Objective

1. To assess the groundwater quality of the present study area with reference to Fourteen water quality parameters viz: pH,colour ,alkalinity turbidity Calcium, Chlorides, Fluorides,TotalHardness, Magnesium, Iron, Sulphate, Nitrates, Electrical conductivity and Total Dissolved Solids.
2. To study the suitability of groundwater for drinking by evaluating water quality Index by Weighted Arithmetic Index method.
3. To identify principal pollutants in the study area for drinking and domestic purposes
4. To classify and assess the groundwater in the study area for drinking domestic suitability as per the criteria suggested by bureaus of Indian Standard

CHAPTER-2

LITERATURE REVIEW

Ground water sources are degraded gradually due to pressure of human activity, urbanization and industrialization. Therefore pure, safe, healthy and odorless drinking water is a matter of deep concern. Various workers have carried out extensive studies in the relevant area.

The main objective of the present study is to assess the suitability of groundwater of the study area for drinking purposes In general literature review was taken out by referring to some standard publications and reference books. The major work brought out by many researchers is compiled.

Kumar et al., (2017) worked on the Effect of Sugar Mill Effluents on Ground Water Quality the work proposed at assessing the quality parameters, groundwater samples of different sources were collected from around the sugar mills placed at Gopalganj and Samastipur, Bihar. All 30 groundwater samples were prepared for the detailed investigation of different parameters following the official guideline of APHA, WHO study under research alarming pH ranges (6.8-8.6), 400-1350 mg/l of Ca^{2+}+Mg^{2+}, CO_3^{2-} + HCO_3^{-} (95-520 ppm in terms of $CaCO_3$) and (234.3-468.4) ppm chloride concentrations were Obtained might be certainly problematic for drinking purposes. Amongst the concentration of the parameters of chloride, CO_3^{2-} +HCO_3^{-} and Ca^{2+} + Mg^{2+} were found exceeding the allowable limit (with the rising trend of Ca^{2+}+Mg^{2+} around up to 8-10 km from both the sugar mills) for irrigation. Based on the categorization of irrigation classes the study showed that the sources fall under either medium or high salinity risks required special consideration for irrigation purposes.

Yadav et al., (2014) carried out a study on ‘Effect of Sugar mill on Physico-Chemical Characteristics of Groundwater of Surrounding Area’ The present research was proposed to determine the influences of the sugar industry on groundwater quality of area near the sugar industry. Groundwater samples were obtained from 10 different places nearby the Panipat Sugar industry analyzed various physicochemical parameters include color, taste, odor, temperature, pH, Alkalinity, Total Dissolved Solids, Total Suspended Solid, Total Solids, Dissolved Oxygen, Chemical Oxygen Demand, and Biological Oxygen Demand. In this research, paper results reveal that some parameters like Alkalinity, Total Dissolved Solid, and Chemical Oxygen Demand of groundwater have exceeded the allowable limit given by the Bureau of the Indian standard Limit of drinking water. It is shown that groundwater is unfit for drinking purposes because of the high level of alkalinity, COD, TDS and low level of DO. This water can be used for irrigation purposes.

Agale M.C. et al., (2013) worked on 'Impact of sugar industry effluents on the quality of groundwater from Dahiwad Village, Dist-Dhule, (Maharashtra) in this study, the different parameters of groundwater was considered from the sugar industry. The groundwater samples were gathered in the region of Dahiwad village the groundwater samples were gathered in the region of Dahiwad village during the period of 10 months from Jan to Oct and examined many Parameters like DO, hardness, alkalinity, Magnesium, Nitrate, Phosphate, Chloride, Sulphate, pH, were evaluated to estimate the influence of effluents on groundwater. The outcomes showed that there was a significant variation in the corresponding parameters. When got results correlated with the BIS (1990) Norms for drinking water. Most of the parameters during the present study do not meet the water quality norms as per BIS (1990). Now it is transparent that the groundwater becomes polluted due to sugar industry effluents from enclosed areas. So, it is not fit for drinking purposes without prior treatment. Furthermore, the water is used for irrigation and domestic purposes in that area. In the present investigation, it was observed that the sugar industry effluents affect groundwater quality. On the basis analysis, it can be said that the groundwater in the region of sugar mill was polluted due to a higher concentration of chlorides, nitrates, magnesium and total hardness which was higher than BIS (1990) standards for drinking water.

Kawade and Gadhave, (2015) carried out the study on "Portability of Ground Water from Areas around a Cane- Sugar Industry: A Case Study from Sangamner village, Ahmednagar, Maharashtra, India'. The present study aims to assess the influences of cane sugar production on its nearby groundwater status. The study includes the examination of eight water samples from tube-wells near to the industry for water quality parameters such as pH, DO, BOD, COD, total dissolved solids, Ca, Mg, Na, Zn, K, Cl, and Fe.the obtained result compare with standard permissible limits prescribed by the Board of Indian Standards (BIS). The result reveals that the groundwater has been significantly affected and is not fit for consumption and cultivation

Sharma et al., (2013) conducted the study on 'Evaluation of Ground Water Quality in Region of Industries and Along Yamuna River in Yamuna Nagar, Haryana, India'. In this study, to estimate the fitness of groundwater quality for drinking and watering purposes in the neighborhood of three chosen industries sugar mill, paper mill, thermal power plant and along Yamuna River located in Yamuna Nagar District of Haryana state, India. The groundwater samples were gathered from three industries of the selected site and several parameters were examined like pH, Electrical Conductivity, Total Dissolved Solids, Dissolved Oxygen, Alkalinity, Total Hardness, Calcium, Sodium, Potassium, Chloride, Magnesium, Carbonate, Bicarbonate, and Turbidity. The obtained results correlated with the WHO 2004 (World Health Organization) and BIS 2003. It also examined sodium percentage (Na %), Sodium Absorption Ratio (SAR), Residual Sodium Carbonate (RSC), and the Permeability Index (PI) for assessing of groundwater for agricultural plan. This paper exposes that some parameters like electrical conductivity, alkalinity, hardness, potassium, and magnesium of groundwater have passed the allowable limit, showing that this area is characterized by hard water. SAR, Na%, RSC, and PI show that groundwater is fit for irrigation purposes and after proper remedy can be used for drinking and residential purposes.

Sharma et al., (2013) conducted the study on 'Evaluation of Ground Water Quality in Region of Industries and Along Yamuna River in Yamuna Nagar, Haryana, India'. In this study, to estimate the fitness of groundwater quality for drinking and watering purposes in the neighborhood of three chosen industries sugar mill, paper mill, thermal power plant and along Yamuna River located in Yamuna Nagar District of Haryana state, India. The groundwater samples were gathered from three industries of the selected site and several parameters were examined like pH, Electrical Conductivity, Total Dissolved Solids, Dissolved Oxygen, Alkalinity, Total Hardness, Calcium, Sodium, Potassium, Chloride, Magnesium, Carbonate, Bicarbonate, and Turbidity. The obtained results correlated with the WHO 2004 (World Health Organization) and BIS 2003. It also examined sodium percentage (Na %), Sodium Absorption Ratio (SAR), Residual Sodium Carbonate (RSC), and the Permeability Index (PI) for assessing of groundwater for agricultural plan. This paper exposes that some parameters like electrical conductivity, alkalinity, hardness, potassium, and

magnesium of groundwater have passed the allowable limit, showing that this area is characterized by hard water. SAR, Na%, RSC, and PI show that groundwater is fit for irrigation purposes and after proper remedy can be used for drinking and residential purposes.

Yadav et al., (2015) conducted the study on 'Impact of Sugar Industry Effluents on the Quality of Groundwater near Bankhedi Sugar Industry Dist. Narsinghpur (Mp) India. 'The present study was concentrated on the influence of sugar mill effluent on groundwater which is utilized for residential purpose, the quality of groundwater was examined from Jan to Dec (2012). In this study, the various parameters like pH, Electrical conductivity, DO, BOD, COD, Alkalinity, Hardness, Chloride, Sulphate, Phosphate, TDS are analyzed in the nearby area of the sugar industry. The study shows that water quality parameters nearby the sugar industry is very high and exceeds the allowable limits. The study also has resulted in various policy reforms and strict governing rules for water quality preservation in the system are needed. There is a requirement for continuous monitoring of contamination near the sugar industry.

Srinivas et al., (2013) carried out a study on "Determination of Water Quality Index (WQI) in Industrial areas of Kakinada, Andhra Pradesh, INDIA" the purpose of this study to measure the water quality index of industrial areas of well water samples in Kakinada; Andhra Pradesh, India was observed. The study was carried out at the 10 sampling stations of the industrial areas of Kakinada. For the computation of the water quality index, thirteen necessary parameters were taken. The parameter like pH, Dissolved oxygen, Electrical Conductivity, Total Dissolved Solids, Total Alkalinity, Total hardness, Total suspended Solids, Calcium, Magnesium, Chlorides, Nitrates, Sulphates, Biological oxygen demand. The WQI has been estimated by using the standards of drinking water quality approved by the World Health Organization (WHO), the Indian Council of Medical Research (ICMR) and Bureau of Indian Standards (BIS) have been used for the computation of WQI of the water body. Water Quality Index of this area ranged from 49.52 – 123.54 ppm showing that level of pollution load in the bore waters. This study shows that some bore well waters are the allowable limit. But some are passed the allowable limit. In the paper, the water was not according to drinking standards, and hence it is recommended to take all the important precautions before the waters are conveyed within the municipal distribution system.

Vipin Kumar Swaroop et al., (2018) conducted the study on **"**Assessment of groundwater quality using water quality index in Unnao Dist, Uttar Pradesh India. The work aimed at assessing the groundwater quality in the Unnao district which is placed in the alluvial plain of River Ganges. Total 11 Physico-chemical parameters were chosen such as pH, Cl^-, NO_3^-, F^-, and SO_4^{2-}, TH, Ca^{2+}, Mg^{2+}, TDS, TA and Fe for determining their concentration in each block of the research area and were Moreover utilized to estimate the Groundwater Quality Index (GWQI) of 16 blocks. Another parameter, Cr (VI) was also considered for determining its fitness of groundwater for drinking purpose, as Unnao district is a center of numerous industries which enhances the probability of percolation of Cr (VI) into groundwater through pores. The study reveals that the groundwater in 4 blocks is extremely unfit for drinking purposes as their similar GWQI values are more than 100. Due to the presence of chromium (VI) in two blocks beyond the allowable limit, it becomes a matter of concern for the safety of the residents in that area as chromium is extremely toxic to human beings. As stated above, just four blocks were in the region of good drinking water, this also arises the necessity for the groundwater authority to take remedial actions in this regard. It can be overall concluded that the drinking water is quite unfit in certain areas but with some satisfactory measures, it can be prevented from moreover deterioration.

Shivasharanappa et al., (2011) work carried out on "Assessment of groundwater quality characteristics and Water Quality Index (WQI) of Bidar city and its industrial area, Karnataka State, India the present work is aimed at evaluating the water quality index (WQI) for the groundwater of Bidar town and its industrial zone. In this study collecting the groundwater sample of selected 35 wards for physicochemical examination. For assessing the WQI, the following parameters were analyzed such as pH, total hardness, calcium, magnesium, chloride, nitrate, sulfate, total dissolved solids, iron, fluoride, sodium, potassium, alkalinity, manganese, dissolved oxygen, total solids, and zinc. The result reveals that the water quality index (WQI) comes in the Excellent Range and therefore the groundwater of Bidar town is as considered as Excellent. The investigation reveals that the groundwater of the area, requires a certain degree of treatment before consumption (at least disinfection), and it also needs to be preserved from the risks of pollution.

Matta et al., (2014) carried out a study on 'Effect of industrial effluent on groundwater quality with special reference to DO, BOD and COD'. The present study was performed by obtaining groundwater samples from a different site The following sites hand pumps (as groundwater), star paper mill and distillery, Saharanpur (U.P.) from three separate locations of each site in Saharanpur district, The following parameter such as pH, temperature, dissolved oxygen (DO), biological oxygen demand (BOD), and chemical oxygen demand (COD), were examined. The result shows that all of the sampling sites, the value of many parameters vary significantly due to harmful chemicals in effluent and seepage of effluent into groundwater. Based on many parameters examined it was concluded that the water quality in Saharanpur District is not pleasing. The investigation statement clearly shows that the water after treatment can be reused in the industry itself and further in irrigation.

Lokhande et al., (2014) work carried out on 'Evaluation of Ground Water Quality of M. I. D. C. Area, Roha through Water Quality Index Assessment". The present study was conducted by collecting groundwater samples near the industrial area of four different sites in Dhatav village, Roha town and groundwater evaluated by using the water quality index method. In this study getting the groundwater sample in the region of an industrial area and examined the parameters contains, pH, electrical conductivity (EC), dissolved oxygen (DO), Alkalinity, Total Hardness (TH), Total dissolved Solid (TDS), Biochemical Oxygen Demand (BOD), Chloride (Cl), Turbidity, Sulfate (SO_4), Ammonia (NH_3) were then examined in the lab according to the standard method (APHA). The result reveals that the values of parameters like electric conductivity, dissolved oxygen, turbidity were beyond the allowable limit. The water quality index values reveal that the status of Groundwater is good.

David et al., (2014) work carried out on "Impact of Dyeing Industry Effluent on Groundwater Quality by Water Quality Index and Correlation Analysis**".** The present study was proposed at investigating the influence of dyeing industry effluent on groundwater status in Chinnalapatti, Tamilnadu, India. Groundwater was obtained from different places in the region of dyeing industries the present study was proposed at investigating the influence of dyeing industry effluent on groundwater status in Chinnalapatti, Tamilnadu, India. Groundwater was obtained from different places in the region of dyeing industries and examined many physicochemical parameters such as pH, Electrical Conductivity, Hardness, Calcium, Magnesium, Sodium, Chloride, Total Dissolved Solids, Potassium and Sulphate.

The obtained result data compared with the Indian standard drinking water then it is concluded that pH, Calcium, Magnesium were within the allowable as well as acceptable limit and Sulphate, Sodium and Potassium were within the acceptable limit only. Also in paper calculated Water Quality Index to assess the level of contamination and index is 61; it shows the contamination rate of groundwater within slight and moderate. When calculating the coefficient of correlation for many water quality parameters to establish the type of relationship between them. From results, EC is positively correlated with Sodium; similarly, TDS and Hardness are positively correlated with calcium.

CHAPTER-III

METHODOLOGY

3.1 GENERAL

Our earth has almost three-fourth of its surface covered by water. Water pumped is being used for various purposes. For the past twenty years, many industries and factories are set up due to the dynamic growth of globalization and strong financial support of the government. When water gets mingled with the garbage and effluents through industries, it loses its originality. Water which gets contaminated due to the threat of environments is cause for spread of epidemic diseases. The polluted water affects health of all beings. It is felt that water analysis has to be carried out for critical water quality parameters.

Regarding the water quality monitoring, scientists and technical experts do their research. Investigations go on to identify the polluted areas. Therefore, necessity of monitoring on the water quality has arisen. This chapter deals with materials used and methods adopted to probe quality of water. Water springs from natural sources and so it is duty of everyone to keep water from deterioration. The study area gives a clear picture about impure water quality which is available on account of effluents treated by traditional sectors of industry such as textiles, chemical industries and engineering goods. To be free from hazardous health, water quality is to be analyzed. The flow chart for detailed methodology is illustrated in Figure 4.1.

The tasks can basically be divided in to the following categories.

1. Collection of water samples and physico-chemical analysis
2. The outcome sample result compare with Bureau of Indian standard
3. Determination of Water Quality Index (WQI) with reference to BIS standards] for portability.

This chapter deals with the methodology involves in performing the above tasks and obtaining the results needed for analysis and ultimate solution of the problem identified. The overall methodology adopted for the present study is presented in the form of flow chart Shown in Fig. 3

3.1.1 Sample collection and Physico-Chemical analysis

In the present study, the assessment of groundwater quality using water quality index within the radius of the Rauzagaon village Sugar Mill in Ruduli Tahshil in Faizabad District The collected groundwater samples have been analyzed in Environmental Laboratory of (Sawen laboratory) using standard methods given by APHA1.The coordinates of the district lies between . (26° 46′ 22.8″ N, 82° 8′ 45.6″ E) The study site map shown in figure1.2 and flow chart of detailed study given bellow

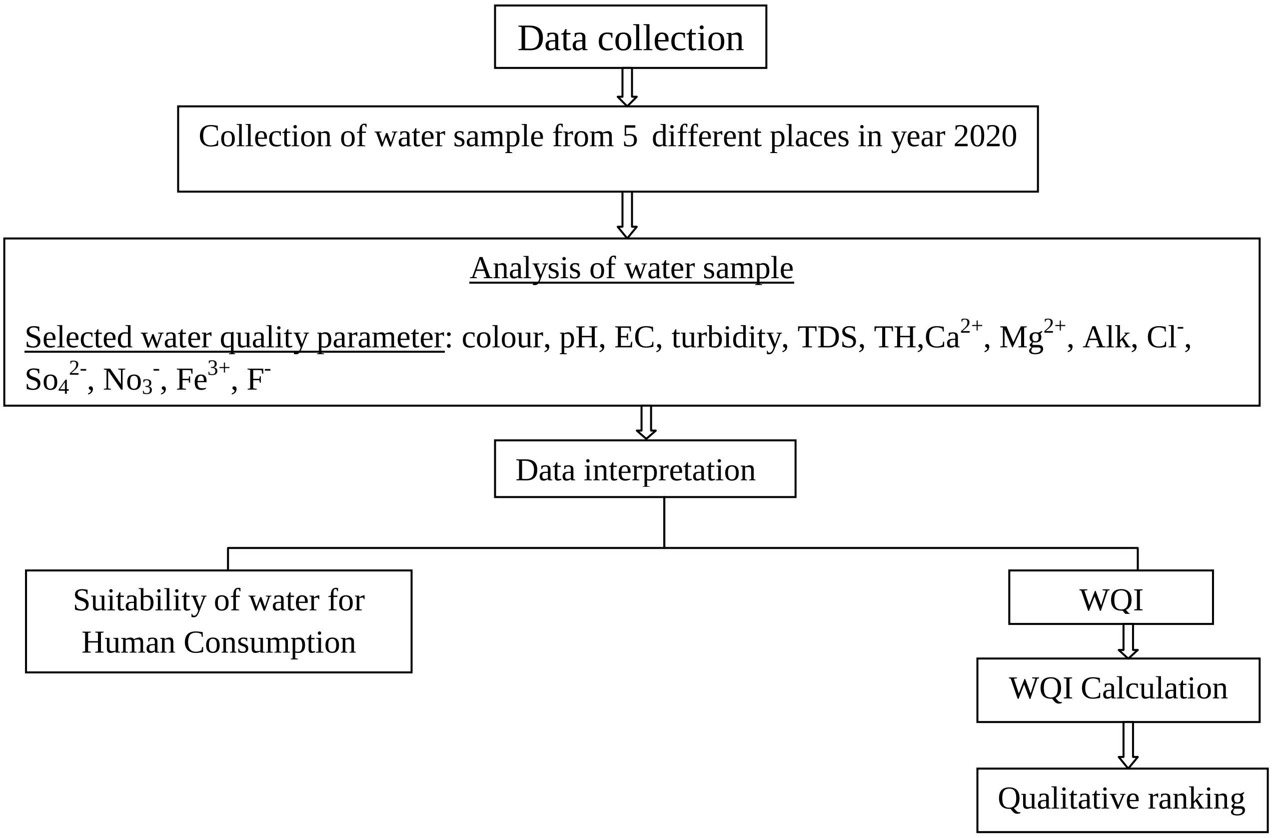

Figure 3.1 Flow chart for Detailed Methodology

3.1.2 Sampling stations

The five Smpling station selected within the radius of Ruzagao village Sugar Mill and Tanda khulasa village where ground water used to drinking purposes the Study Area The statistics of the sampling details are listed in Table 3.1.

Table 3.1: Name of villages of rudauli tahsil in faizabad district used for water sampling

Radial distance from centre in (m)	Sample location	sources	coordinates
100	Rauzagaon village	Bore well	26^{0} 47’ 13.2”N, 81^{0} 47’ 35.6” E
200	Tanda Khulasa	Bore well	26^{0} 47’ 13.1”N, 81^{0} 41’ 27.6” E
500	Residential area	BW	26^{0} 47’ 33.9”N, 81^{0} 41’ 27.6” E
2km	Residential area	BW	26^{0} 47’ 12”N, 81^{0} 41’ 35.4” E
Above 3	Residential area	BW	26^{0} 47’ 6.3”N, 81^{0} 41’ 24.9” E

3.1.3 Sample collection

Groundwater samples were collected using standardized polyethylene bottles with 1 litre capacity. It was ensured that all the sampling bottles were thoroughly washed with 2% dilute HNO3, in addition to it the bottles were also rinsed with distilled water before taking the samples. It was also assured that all the bottles were washed with sample water about 2-3 times before sampling. Selected physico-chemical parameters were measured within 24 hours of the collection of samples. All sample collected where the people are use to drinking purposes

The groundwater samples are collected from tube wells varying in depth from 90 to 130.Foot the water sample of about one liter from each Bore well are collected in clean polythene bottles. Total 5 samples were taken for the determining the concentration of 14 physico-chemical parameters such as Colour, Odour, Taste, pH, value Turbidity ,T.D.S(Total dissolved solids),T.H(Total Hardness), Alkalinity, Fluoride, Chloride, Calcium, Magnesium, Iron, Sulphate, Niterate, Electrical conductivity the sample collected in 1L Plastic bottle and proper labeled of sample shown in fig

Figure. 3.2 collection of sample with labeled on bottle

3.1.4 Total number of samples

In the entire total study period of the year 2020 total 5groundwater samples are collected for the present study.

3.1.5 Physico- Chemical analysis

Samples are analyzed in the laboratory by using standard methods of analysis (APHA, 23rd Ed 2017). High purity (A.R. Grade) chemicals and double distilled water is used for preparing standard solutions for analysis. Various physical parameters like pH, EC, and TDS are determined on the spot with the help of digital portable pH meter, Conductivity meter and TDS meter. Total hardness is measured by EDTA titrimetric method using EBT indicator16. The chloride ions are determined by titrate the water samples against a standard solution of AgNO3 using potassium chromate as indicator. Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Carbonate (CO_3^{2-}) and Bicarbonate (HCO_3^-) are also determined by volumetric titration methods. While Sodium (Na+) is determined by Flame photometry as recommended by APHA. Nitrates (No_3^-) and Fluorides of the water samples are estimated by UV visible spectrophotometer.

3.1.6 Physico- chemical parameters

Summary of methods used for analysis of physico-chemical parameter of water samples is given in Table 3.2

Table 3.2: Characteristics studied and the methods used for analysis of physicochemical Parameters of water

Parameter tested	Method	Test protocol
Colour		2120 B APHA 23rd Ed. 2017
pH	Electrometric Method	4500-H B,APHA' 23rd Ed. 2017
Electrical Conductivity	Laboratory Method	2510 B.APHA' 23rd Ed. 2017
Turbidity	Nephelometric Method	2130 B APHA' 23rd Ed. 2017
Total dissolved Solids	TDS at 180ºC	2540 C. APHA'23rd Ed. 2017
Total Hardness as $CaCo_3$	EDTA Titrimetric Method	2340 C. B APHA'23rd Ed. 2017
Calcium as Ca	EDTA Titrimetric Method	3500 B. APHA' 23rd Ed. 2017
Magnesium as Mg	Calculation Method	3500 B, APHA' 23rd Ed. 2017
Alkalinity as $CaCo_3$	Titration Method	2320 B, APHA' 23rd Ed. 2017
Chloride as Cl^-	Argentometric Method	4500-Cl- B, APHA' 23rd Ed. 2017
Sulphate as So_4	Turbidimetric Method	4500-SO_4-E. APHA' 23rd Ed. 2017
Niterate as No_3	UV Spectrophotometric Screening Method	4500-No_3 B. APHA' 23rd Ed. 2017
Iron as Fe	Phenanthroline Method	3500 Fe- B APHA' 23rd Ed. 2017
Fluoride F^-	SPADNS Method	4500-F-APHA' 23rd Ed. 2017

3.2 GEOCHEMICAL ANALYSIS

Hydro geochemical studies are used to understand the subsurface geological environment, direction of movement of groundwater, recharge-discharge relationships, influence of climate and anthropogenic contaminants, presence of ore bodies and the economic evaluation of mineral rich waters.

In order to obtain reliable and representative results, standard groundwater collection, preservation and analysis procedures are needed. Standard procedures prescribed by American Public Health Association (1995) were followed for this study.

The chemical analyses were carried out using standard procedures for the determination of parameters such as electrical conductivity (EC), hydrogen ion concentration (pH), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^{+}), potassium (K^{+}), bicarbonate(HCO_3^-), sulphate (SO_4^{2-}), nitrate (NO_3^-) and chloride (Cl^-) in the laboratory of Institute for Water Studies, Taramani, Chennai. Reagents were prepared using double distilled water for groundwater quality analyses.

3.2.1 Determination of Hydrogen ion concentration (pH)

pH is a logarithmic expression of the hydrogen ion concentration and reflects the degree of acidity (pH less than 7) or alkalinity (pH greater than 7) of the water.

Method

The pH of the water sample is determined by electrometric method by means of a pH meter with glass electrode.

Principle of determination

The pH of a solution is a measure of the effective hydrogen ion concentration or more specifically the Hydrogen ion activity. This method employs calibrated potentiometer with glass and calomel electrodes immersed in the test sample. The electrodes develop a potential (emf) proportional to pH of the water sample being immersed. The potentiometer measures emf. The electrode systems are being calibrated using standard buffer solutions of 4.0, 7.0 and 9.2.

3.2.2 Determination of Electrical Conductivity

Method

The Specific Conductance of the water sample is determined using a conductivity meter.

Principle of determination

The specific conductance is a measure of the ability of water to carry an electric current and is therefore an indication within rather wide limits, of the ionic strength of the solution. The specific conductance of an electrolyte is the reciprocal of specific resistance and is expressed in mhos or siemens per meter (S/m).

Specific resistance is the resistance in ohms of a column of solution 1cm long and 1 sq.cm in cross section. In most waters, the conductance is so low that micromho or microsiemens is used as the unit of expression.

Several kinds of instruments for measuring specific conductance are available. Wheatstone bridge is used where the variable resistance is adjusted to equate to the resistance of the unknown solution between Platonized electrodes of a standardized conductivity cell. The instrument is designed to work with a particular form of conductivity cell and designed to present the readings in terms of conductivity (or conductance) units at $25^{o}C$.

3.2.3 Determination of Calcium

Method

To determine the calcium content, a complexometric method is employed, in which the water sample is titrated against standard EDTA solution using murexide (commercially as calcium hardness indicator) as indicator.

Principle

Disodium dihydrogen ethylenediamine tetraacetate (Na2EDTA) forms a slightly ionized, colorless, stable complex with calcium ions. In the absence of Ca, Murexide exists as bluish violet in colour but with calcium, it forms a light salmon - colored complex which has ionization constant higher than the Na_2EDTA complex. Hence, by using murexide as an indicator, a solution containing calcium ions may be titrated with Na_2EDTA. The titration is carried out at pH of 12, which is attained by the addition of 4N sodium hydroxide solution.

When a Metal ion indicator (murexide in the present case) is added to the water sample, it combines with the metal (calcium in this case) to form the Metal-indicator complex (M-In), which has a distinct colour (light salmon in this case). When titrated with Na_2EDTA, the following reaction takes place:

M-In + EDTA = M - EDTA (metal – EDTA Complex) +In (Free Indicator)

During titration, the metal from the Metal indicator complex M-In dissociates and the free metal ions are progressively complexed by the EDTA into Metal EDTA (M-EDTA) complex, until all the metal ions are displaced from the complex M-In to leave the free indicator (In). At this equivalence point, a colour change occurs (bluish violet), which is that of the free indicator at the chosen pH of 12.

Traces of many metals, such as Co, Ni, Cu, Pb, Zn, Hg and Mn, interfere in the determination of calcium by the complexometric method. The interference of such heavy metals is minimized by the addition of hydroxylamine hydrochloride (NH2OH.HCl), which reduces these metals to their lower valency states.The titration should proceed immediately upon the addition of the indicator, so as to prevent the precipitation of calcium carbonate.

20ml of water sample or the diluted water sample, as the case may be is pipetted into a conical flask. 1ml of Hydroxylamine hydrochloride (4.5% solution), 1ml of sodium hydroxide (4N solution) and 0.2g or 2 drops of murexide indicator are added successively. The solution turns light salmon and titrated against Na_2EDTA (0.02 N solution) until the colour changes from salmon to violet. The volume of the titrant added is noted.

Calculation

If V is the volume in ml of Na_2 EDTA, 0.02N added, P is the dilution proportion of the sample,

$$Ca = (VxP)\ meq/L$$

$$(Vx20.04xP)\ mg/L$$

3.2.4 Determination of Magnesium

Method

The magnesium concentration of the water sample is calculated from the total hardness and the calcium concentrations determined separately by the complexometric method.

Procedure

1. The calcium concentration of the sample is determined as described.

2. The total hardness of the sample as described is determined.

3. Magnesium concentration is determined from the total hardness and calcium concentrations.

Calculation

$$Meq/L\ Mg = (meq/L\ Total\ Hardness) – (meq/L\ Calcium).$$

$$Mg/L\ Mg = (meq/L\ Mg)\ x\ 12.16$$

3.2.5 Determination of Alkalinity

Method

The sample is titrated against standard sulfuric acid in two steps, first to the phenolphthalein end point at pH 8.3 and then to the methyl orange end point at pH 4.5.

Principle: Alkalinity is the term conferred on those constituents that can be titrated with strong mineral acids. Alkalinity in water is caused primarily by the presence of bicarbonates, carbonates and hydroxides. Alkalinity is determined by titrating the water sample with a standard solution of sulfuric acid. The equivalency or end point of titration is selected as the inflection points in the titration of Na2CO3 with H2SO4.

The following reaction occurs:

$CO_3^{2-} + H^+ \longrightarrow$ HCO3 (Titration to phenolphthalein end point at pH 8.3 represents 50% of the carbonate ions.)

HCO_3^- (from CO_3) + $H^+ \longrightarrow$ H2O +CO_2 (titration to pH 4.5, methyl orange end point)

HCO_3^- (natural) + $H^+ \longrightarrow H_2O + CO_2$

Alkalinity is very susceptible to change between time of collection and analysis. Changes occur more rapidly after the sample bottle is opened. Hence, it is advisable to analyze the sample as soon as the sample is opened.

Procedure: 20ml of the sample was pipette into a conical flask, 3 drops of phenolphthalein indicator was added, the solution turns pink and then titrated against standard sulphuric acid of 0.02N with continuous stirring until the colour just changes from pink to that of the original sample. The volume of sulphuric acid was recorded as A ml. To the same solution in the flask, which had been titrated to the phenolphthalein end point, 2 or 3 drops of methyl orange indicator were added. The solution turns yellow. The titration was continued with sulphuric acid, until the sample turns from yellow to orange indicating the methyl orange end point (pH 4.5). The volume of sulphuric acid used to reach the methyl orange endpoint (including that for the phenolphthalein end point) was recorded as B ml.

Calculation

$$\text{Total alkalinity as } CaCO_3 = \text{B meq/L}$$

$$= (\text{Bx}50.05) \text{ mg/L}$$

$$CO_3 = 2\text{A meq/L}$$

$$= (2\text{Ax}30) \text{ mg/L}$$

$$HCO_3 = (\text{B} - 2\text{A}) \text{ meq/L}$$

$$= (\text{B} - 2\text{A}) \text{ x } 61 \text{ mg/L}$$

3.2.6 Determination of Nitrate

Apparatus

Nitrate concentration is determined using Spectrophotometer at a wavelength of 220nm with matched silica cells of 1 cm or longer light path.

Reagents a. Nitrate free water: Redistilled or de-ionized water is used to prepare all solutions.

b. Stock Nitrate Solutions: 0.7218g KNO3, earlier dried in hot air oven at 105ºC overnight and cooled in desiccator is dissolved in distilled water and diluted to 1L.

c. Standard Nitrate Solution: 100 ml of Stock solution is diluted to 1000ml with distilled water.

d. Hydrochloric acid solution 1N: 83 ml conc. HCl is carefully added to about 850 ml of distilled water with continuous stirring, cooled and diluted to 1 litre.

Procedure

a. Treatment of sample: 1 ml HCl is added to 50 ml clear / filtered sample.

b. Spectrometer measurements: Read absorbance or transmittance against re-distilled water set at zero absorbance or 100% transmittance. Use a wavelength of 220 nm to obtain NO3- reading and a wavelength of 275 nm to determine interference due to dissolved organic matter.

Calculation

For sample and standards, subtract 2 times the absorbance reading at 273nm, from the reading at 220nm to obtain absorbance due to NO3-. Sample concentrations are obtained directly from the calibration curve.

3.2.7 Estimation of Sulphate

Principle

It is based on turbidity of spectrometric method; the concentration of a substance is determined by measurement of the relative absorption of light with respect to a known concentration of the substance.

Apparatus

a. Nephelometric turbidity meter with sample cells.

b. Magnetic stirrer.

c. Timer with indication seconds.

Reagents

a. Buffer solution A: 30g magnesium chloride, $MgCl.H_2O$, 5g sodium acetate, $CH_3COONa.3H2O$, 1g potassium nitrate, KNO_3 and 20ml acetic acid CH_3COOH (99%) are dissolved in 500 ml of distilled water and then made up to 1000 ml with distilled water.

b. Buffer solution B: If the sample SO_4^{2-} concentration is less than 10 mg/L, a buffer solution B is prepared from buffer solution A by adding 0.111g of sodium Sulphate, Na_2SO_4.

c. Barium chloride, $BaCl_2$, crystals, 20 to 30 meshes.

d. Standard Sulphate solution: 10.4 ml standard 0.02N H_2SO_4 is diluted to 100 ml (1.00 ml = 100µg SO_4^{2-})

e. Standard sodium carbonate, approximately 0.05N. 3 to 5 g sodium carbonate, Na_2CO_3 is dried at 250ºC for 4 hours and cooled in a desiccator. 2.5±0.2g is accurately weighed to the nearest mg, dissolved in distilled water and made upto 1litre.

Standard H_2SO_4, approximately 0.1N 2.8 ml conc. Sulphuric acid is diluted to 1litre and standardized against Na_2CO_3.

Procedure

Measure 100 ml of sample into a 250 ml of Erlenmeyer flask and add 20 ml of buffer solution and mixed in stirring apparatus. While stirring, a spoonful of Barium Chloride crystals was added. Then, pour the solution into absorption cell and the turbidity measured by using spectrophotometer with visible light at wavelength of 540. Estimate the SO_4^{2-} concentration in sample by comparing the turbidity reading with a calibration curve prepared by carrying SO_4^{2-} standards.

3.2.8 Determination of Chloride

Method

To determine the chloride content, the water sample is titrated with a standard silver nitrate solution, using potassium chromate as an indicator.

Principle When the water sample is titrated with a standard silver nitrate solution, using potassium chromate as the indicator, the silver nitrate precipitates the chloride ion as silver chloride. When the chloride is completely precipitated, the addition of more silver nitrate produces a red colour due to the chromate ions combining with silver ions to form the sparingly soluble, red silver chromate. This is taken as the end point of the titration.

The following reaction occurs:

$$NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$$

$$K_2CrO_4 + 2\ AgNO_3 \longrightarrow Ag_2CrO_4 + 2KNO_3$$

All chlorides present in the sample such as chlorides of magnesium and calcium, as well as sodium, are determined and reported as chlorides.

Procedure

20ml of the water sample or the diluted water sample as the case may be is pipette into the conical conical flask. Four or five drops of potassium chromate indicator chromate indicator solution are added and the solution turns yellow. Silver nitrate solution (0.02N) from the burette is added slowly until the solution just turns from yellow to orange or brick red indicating the end point of the titration. The volume of $AgNO_3$ added is noted.

Calculation

If V is the volume of Silver Nitrate solution (0.02N) added and P is the dilution proportion, then

$$Cl = (VxP)\ meq/L = (Vx35.453xP)\ mg/L$$

3.3 Groundwater quality assessment for drinking purpose

The World Health Organization (1993) has given drinking water quality standards for every chemical parameter. Based on the WHO's standards, the concentrations of each geochemical parameter was reclassified to demarcate the suitability of the groundwater samples. The values of all the parameters were taken into GIS environment for analysing and determining their spatial variations.

Water Quality Index (WQI) is used to assess the groundwater quality for drinking purpose. WQI is defined as a technique of rating that provides the composite influence of individual water quality parameters on the overall quality of water for human consumption. The standards for drinking purposes as recommended by World Health Organization (1993) have been considered for the calculation of WQI.

According to saying of Horton (1965), WQI as a reflection of composite influence of individual quality characteristics on the overall quality of water. Water quality indices aim at giving a single value to the water quality of a source on the basis of one or the other system, which translates the list of constituents and their concentrations present in a sample into a single value. One can compare different samples for quality on the basis of the index value of each sample.

Water Quality Indices can be formulated in two ways: (1) Index numbers increase with the degree of pollution (increasing scale indices) and (2) index numbers decrease with the degree of pollution (decreasing scale indices). One may classify the former as 'water pollution indices' and the latter as 'water quality indices'. But this difference appears as an essential cosmetic: water quality is a general term; of which 'water pollution' that indicates 'undesirable water quality' is a special case. In this study, water quality indices with increasing scale indices were considered. Figure 4.3 illustrates how index values are calculated.

Water sample collection

↓

Result for multiple water quality

Parameters

↓

Select index water quality

Parameter: Ph, TDS, Total alkalinity,etc

↓

Unit weight calculation

↓

Quality rating

Calculation

↓

WQI Calculation

↓

Qualitative ranking**:**

Excellent	(0-25),
Good	(26-50),
Poor	(51-75)
Very poor	(76-100),
>100	unsuitable

Figure 3.2 Process of WQI Calculation

3.4 WQI Values and Water Quality

The several ranges of WQI and the corresponding status of water quality on the basis of increasing scale indices are given in Table 4.5.

Table 3.3 WQI Values and Water Quality

Sn.	WQI	Status	Possible use of water
1	0-25	excellent	All purpose like Potable, Industrial and Agricultural
2	26-50	good	Domestic and Agricultural
3	51-75	Fair	Agricultural and Industrial
4	76-100	poor	Agriculture
5	101-150	Very poor	Not much, possible agriculture
6	151 and above	worst	Can be used only after proper treatment

To calculate WQI, selection of parameters is of great importance. The importance of various parameters depends on the intended use, Fourteen physico – chemical parameters: (1) colour, (2) pH , (3) EC, (4)Turbidity, (5) TDS, (6) T.Alk, (7) TH, (8) Ca^{2+}, (9) Mg^{2+}, (10) $NO3^{-}$, (11) Cl^{-}, (12) SO4 2^{-} and (13), Fe, (14), Fluorid as F^{-}

3.4.1 WQI Calculation

WQI was carried out through adoption of Horton's method and application of modifications proposed by Tiwari and Mishra. The overall WQI for the samples was calculated by weighted arithmetic index method (Brown et al 1972).

4.7.2.1 Calculation of Unit Weight

Unit weight was calculated by a value inversely proportional to the recommended Sn of the corresponding parameter

$$Wn = \frac{k}{Sn} \qquad (4.1)$$

Where Wn - Unit weight for the nth parameters

Sn - Standard value of the nth parameter

K - Constant for proportionality

The water quality parameters and their unit weights (Wn) are depicted in Table 4.6. The value of 'k' in each case is '0.823586'.

Table 3.4 Water quality parameters, their standard values, and ideal Values and unit weights

Sn.	parameter	Standard value (Sn)	Sn from	Ideal Value (Vid)	Unit Weight
1	pH	8.5	IS	7	0.219
2	EC	300	ICMR	0	0.371
3	TDS	500	IS	0	0.0037
4	TA	120	ICMR	0	0.0155
5	TH	300	IS	0	0.0062
6	Ca	75	IS	0	0.025
7	Mg	30	IS	0	0.061
8	Cl	250	ICMR	0	0.0074
9	So_4	150	IS	0	0.01236
10	No_3	45	IS	0	0.0412
11	BOD	5	IS	0	0.3723

3.4.2 Calculation of Quality rating (qn)

Let there be n water quality parameters and qn corresponding to the nth parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value. The qn is calculated using the following expression.

$$qn = \frac{Vn - Vi0}{Sn - Vi0} \times 100 \qquad (4.2)$$

Where qn - Quality rating for the nth water quality parameter

Vn - Estimated value of the nth parameter at a given sampling station

Sn - Standard permissible value of the nth parameter

Vid - Ideal value of nth parameter in pure water

(i.e. 7.0 for pH and 0 for all other parameters)

3.4.3 Calculation of WQI

The overall WQI was calculated by aggregating the qn with the unit weight linearly.

$$\text{WQI} = \frac{\sum \text{Wn} \times \text{qn}}{\sum \text{Wn}} \qquad (4.3)$$

CHAPTER-IV

RESULTS AND DISCUSSION

4.1 General

Water which is used for drinking purpose should be free from toxic elements, living, nonliving organisms and excessive amount of minerals because they may be harmful to human health [57]. Good water quality produces healthier humans as compare to poor water quality. Water should be purified for a better life style because so many chemicals are involved in it.

Water samples were analyzed of different localities for varied physical and chemical parameters including quality parameters for evaluating Water Quality Index (temperature, pH, TH, TDS, EC, Cl, NO_3, So_4, Ca , Mg ,Fe,Total Hardness, turbidity and F) using standard methods[58].

For determining the drinking water quality of Jaipur and its agglomerate WQI was calculated as per Brown R M et al [39].

The work of research was based on the sampling and analysis of ground water from different source (Bore well, hand pump). Radius of Rauzagaon village sugar mill and its residential area and tanda khulasa Study area are divided into five locations

a) Rauzagaon village three sample
b) Tanda khulasa two sample

4.2 Experimental Results

The detail of physico-chemical result with respect acceptable limit and permissible limit sample No. wise shown in following table

Table 4.1 the Observed value of physico-chemical parameter of sample -1

S.NO.	PARAMETER TESTED	UNITS	RESULT	Requirement (Acceptable limits)	Permissible limit in the Absence of Alternate Source
				(IS 10500:2012) Second Revision	
01	Colour	Hazen units	<5.0	5	15
02	pH	-	7.05	6.5 – 8.5	No Relaxation
03	Electrical conductivity	µs/cm	1144	-	-
04	turbidity	NTU	3.4	1	5.0
05	Total dissolved solids	mg/L	744	500	2000
06	Total hardness as $CaCo_3$	mg/L	384	200	600

07	Calcium as Ca	mg/L	38.4	75	200
08	Magnesium as Mg	mg/L	70	30	100
09	Alkalinity as $CaCo_3$	mg/L	364	200	600
10	Chloride as Cl^-	mg/L	48	250	1000
11	Sulphate as So_4^-	mg/L	32.8	200	400
12	Nitrate as No_3^-	mg/L	1.6	45	No Relaxation
13	Iron as Fe	mg/L	0.3	0.3	No Relaxation
14	Fluoride as F^-	mg/L	BDL	1	1.5

4.2.1 Interpretation of sample No. 1

The tested water sample does not suitable as per IS: 10500 Drinking Water specification (second revision) with respet to the above tested parameter the tested parameters like Turbidity, TDS,Total Hardness ,Magnesium and Alkalinity slightly exceeds the requirement (Acceptable limit) in column No. 5 of this report

Table 4.2 the Observed value of physico-chemical parameter of sample- 2

S.NO.	PARAMETER TESTED	UNITS	RESULT	Requirement (Acceptable limits)	Permissible limit in the Absence of Alternate Source
				(IS 10500:2012) Second Revision	
01	Colour	Hazen units	<5.0	5	15
02	pH	-	7.13	6.5 – 8.5	No Relaxation
03	Electrical conductivity	µs/cm	1033	-	-
04	turbidity	NTU	<1	1	5.0
05	Total dissolved solids	mg/L	661	500	2000
06	Total hardness as $CaCo_3$	mg/L	344	200	600
07	Calcium as Ca	mg/L	44.8	75	200
08	Magnesium as Mg	mg/L	56.3	30	100
09	Alkalinity as $CaCo_3$	mg/L	336	200	600
10	Chloride as Cl^-	mg/L	24	250	1000
11	Sulphate as So_4^-	mg/L	26.0	200	400
12	Niterate as No_3^-	mg/L	1.4	45	No Relaxation
13	Iron as Fe	mg/L	BDL	0.3	No Relaxation
14	Fluoride as F^-	mg/L	BDL	1	1.5

4.2.2 Interpretation of sample No.2

The tested water sample does not suitable as per IS: 10500 Drinking Water specification (second revision) with respect to the above tested parameter the parameter like TDS,Total

Hardness,Magnesium,and Alkalinity slightly exceeds the Requirement(Acceptable limit) in column no.5 of this report.

Table 4.3 the Observed value of physico-chemical parameter of sample- 3

S.NO.	PARAMETER TESTED	UNITS	RESULT	Requirement (Acceptable limits)	Permissible limit in the Absence of Alternate Source
				(IS 10500:2012) Second Revision	
01	Colour	Hazen units	<5.0	5	15
02	pH	-	7.28	6.5 – 8.5	No Relaxation
03	Electrical conductivity	µs/cm	691	-	-
04	turbidity	NTU	<1	1	5.0
05	Total dissolved solids	mg/L	456	500	2000
06	Total hardness as $CaCo_3$	mg/L	228	200	600
07	Calcium as Ca	mg/L	46.4	75	200
08	Magnesium as Mg	mg/L	27.2	30	100
09	Alkalinity as $CaCo_3$	mg/L	232	200	600
10	Chloride as Cl^-	mg/L	20	250	1000
11	Sulphate as So_4^-	mg/L	13.1	200	400
12	Niterate as No_3^-	mg/L	1.3	45	No Relaxation
13	Iron as Fe	mg/L	BDL	0.3	No Relaxation
14	Fluoride as F^-	mg/L	BDL	1	1.5

4.2.3 Interpretation of sample No.3

The tested water sample does not suitable as per IS: 10500 Drinking Water specification (second revision) with respet to the above tested parameters , as tested parameter like Total Hardness,and Alkalinity , Slightly exceeds the Requirement (Acceptable limit) In Column no. 5 of this report

Table 4.4 the Observed value of physico-chemical parameter of sample -4

S.NO.	PARAMETER TESTED	UNITS	RESULT	Requirement (Acceptable limits)	Permissible limit in the Absence of Alternate Source
				(IS 10500:2012) Second Revision	
01	Colour	Hazen units	<5.0	5	15
02	pH	-	7.13	6.5 – 8.5	No Relaxation

03	Electrical conductivity	µs/cm	927	-	-
04	turbidity	NTU	<1	1	5.0
05	Total dissolved solids	mg/L	603	500	2000
06	Total hardness as $CaCo_3$	mg/L	308	200	600
07	Calcium as Ca	mg/L	33.6	75	200
08	Magnesium as Mg	mg/L	54.4	30	100
09	Alkalinity as $CaCo_3$	mg/L	310	200	600
10	Chloride as Cl^-	mg/L	28	250	1000
11	Sulphate as So_4^-	mg/L	15.3	200	400
12	Niterate as No_3^-	mg/L	1.8	45	No Relaxation
13	Iron as Fe	mg/L	BDL	0.3	No Relaxation
14	Fluoride as F^-	mg/L	BDL	1	1.5

4.2.3 Interpretation of sample No.4

The tested water sample does not suitable as per IS: 10500 Drinking Water specification (second revision) with respect to the above tested parameters,the parameter like .Total dissolved solids, total Hardness, Magnesium, and Alkalinity Slightly exceeds the Requirement (Acceptable limit) In Column no. 5 of this report

Table 4.5 the Observed value of physico-chemical parameter of sample 5

S.NO.	PARAMETER TESTED	UNITS	RESULT	Requirement (Acceptable limits)	Permissible limit in the Absence of Alternate Source
				(IS 10500:2012) Second Revision	
01	Colour	Hazen units	<5.0	5	15
02	pH	-	7.17	6.5 – 8.5	No Relaxation
03	Electrical conductivity	µs/cm	748	-	-
04	turbidity	NTU	3.3	1	5.0
05	Total dissolved solids	mg/L	486	500	2000
06	Total hardness as $CaCo_3$	mg/L	240	200	600
07	Calcium as Ca	mg/L	32.0	75	200
08	Magnesium as Mg	mg/L	38.8	30	100
09	Alkalinity as $CaCo_3$	mg/L	252	200	600
10	Chloride as Cl^-	mg/L	12	250	1000
11	Sulphate as So_4^-	mg/L	18.8	200	400
12	Niterate as No_3^-	mg/L	1.9	45	No Relaxation
13	Iron as Fe	mg/L	0.3	0.3	No Relaxation
14	Fluoride as F^-	mg/L	BDL	1	1.5

4.2.5 Interpretation of sample No.5

The tested water sample does not suitable as per IS: 10500 Drinking Water specification (second revision) with respect to the above tested parameters , as tested parameter in.Total Hardness , and Magnesium Slightly exceeds the Requirement (Acceptable limit) In Column no. 5 of this report

4.2 pH:

pH value in selected study area varied between 7.5 to 7.13 in Pre Monsoon. All values in the prescribed limit given by bureau of Indian Standard the variation of pH different places at the study area given in figure 4.4.

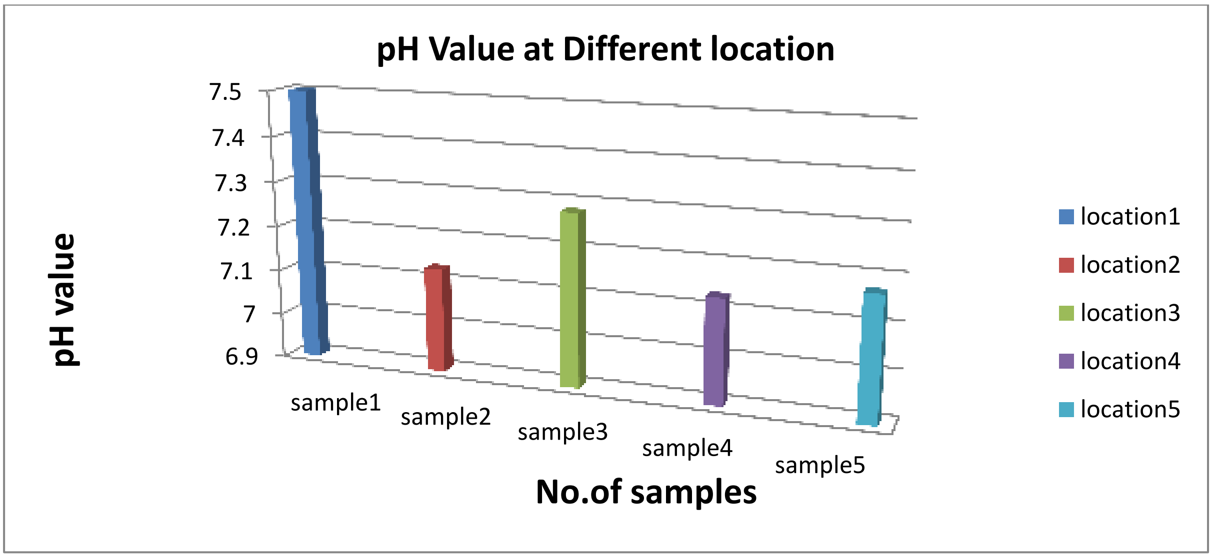

Figure 4.1 the variation of pH, Value locality of Rauza gaon village and Tanda khulasa

4.2.1 Electrical conductivity

The EC value in selected study area varied between the Ranges 1144 to 691 all the sample of Electrical conductivity exceed the permissible limit High conductivity is due to presence of high amount of dissolved salts.

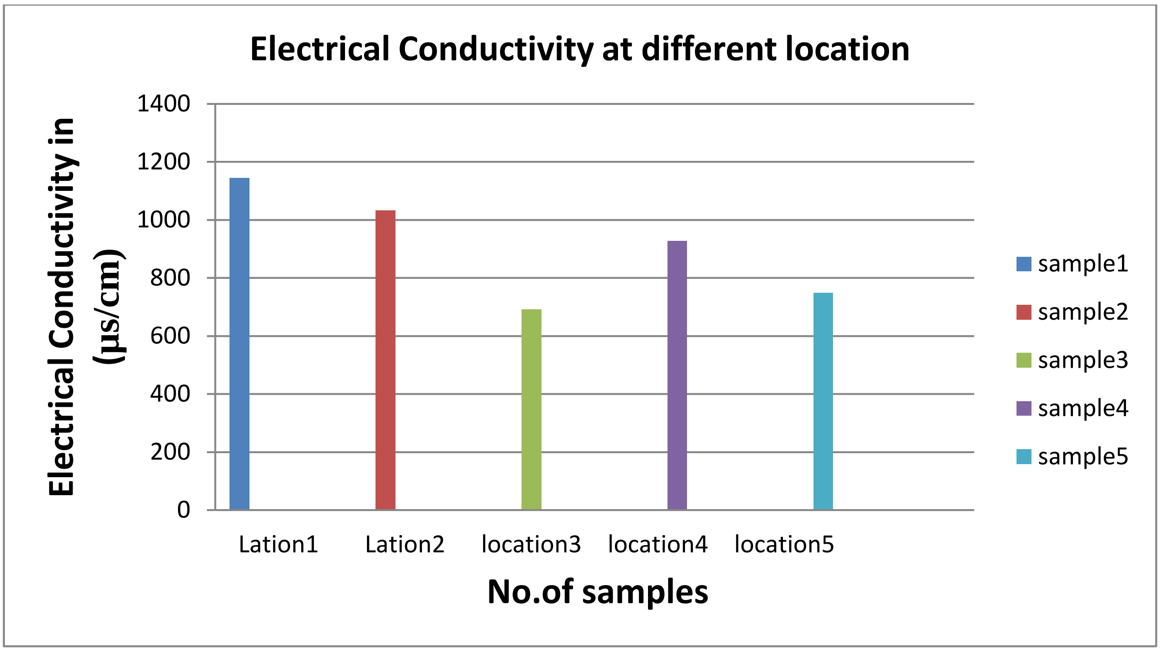

Figure 4.2 the variation of elecrical conductivity, locality of Rauza gaon village and Tanda khulasa

4.2.2 Turbidity

The observed value of turbidity ranges from 0.9 to 3.4 NTU sample No.4 and 5 slightly exceeded the Requirement limit (acceptable limit) prescribed by the IS 10500-2012 high value of turbidity indicate presence of organic matter in water sample.

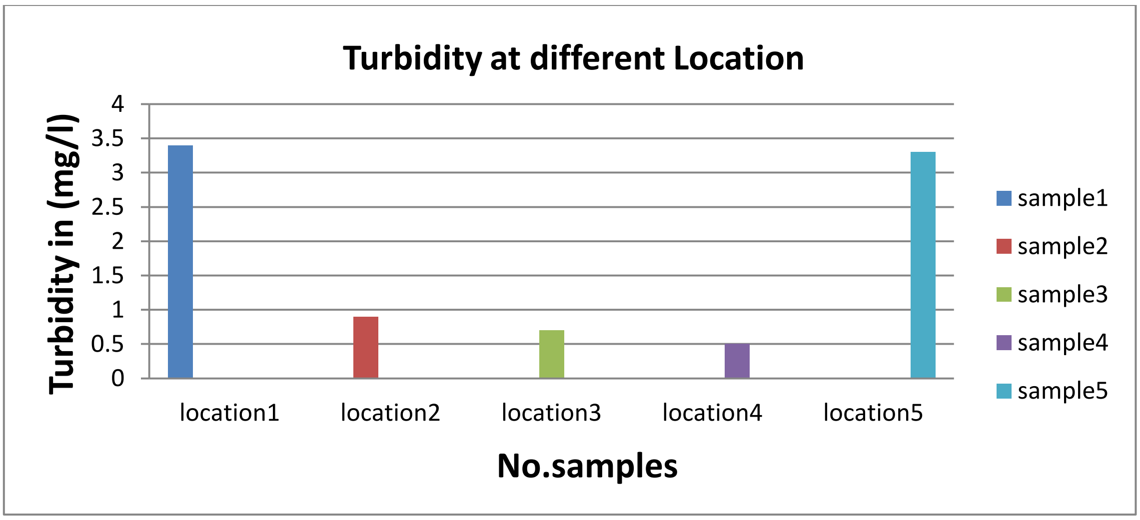

Figure. 4.3 the variation of Turbidity, locality of Rauza gaon village and Tanda khulasa

4.2.3 Total Dissolved Solids

The Total dissolved solids concentration ranges from 456 to 744 mg/L sample No. 1,2,and 3 exceeded the Requirement (Acceptable limit) and sample no.3 and 5 within the Acceptable limit Higher concentration of dissolved solids are samples shows poor quality of water predicted to more seepage and movement of ground water in this area[62].

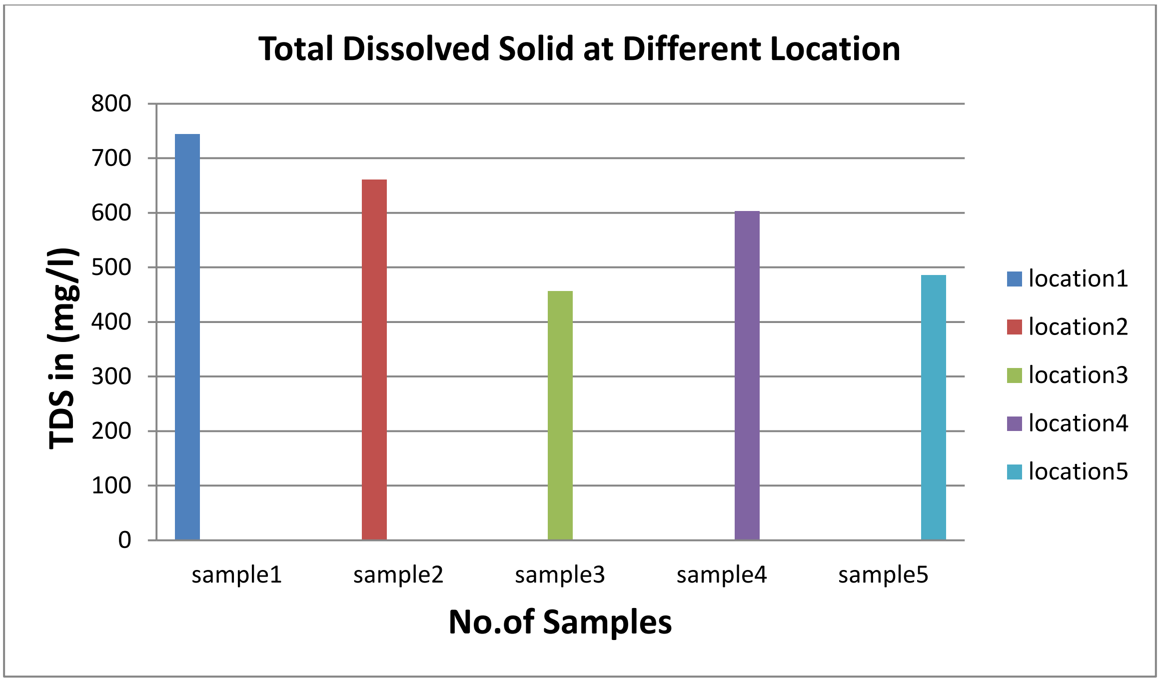

Figure. 4.5 the variation of Total dissolved solid, locality of Rauza gaon village and Tanda khulasa

4.2.4 Total Hardness

Observed total hardness varied between 228 to 384 mg /Lground water were found to exceed the acceptable limit of IS 10500-2012 The natural sources of hardness in water are dissolved in the form of polyvalent metallic ions (i.e. calcium and magnesium) from sedimentary rocks, seepage and runoff from soils58. High value of total hardness leads to heart diseases and kidney stone problem81 as human health problems.

Table 4.6: Classification of Hardness based on the water class

S.No.	Hardness (CaCO3 equiv) in ppm *	Water class
1	0-75	Soft
2	75-150	Moderate Hard
3	150-300	Hard
4	More than- 300	Very hard

(ppm =Parts per million = mg/L)*

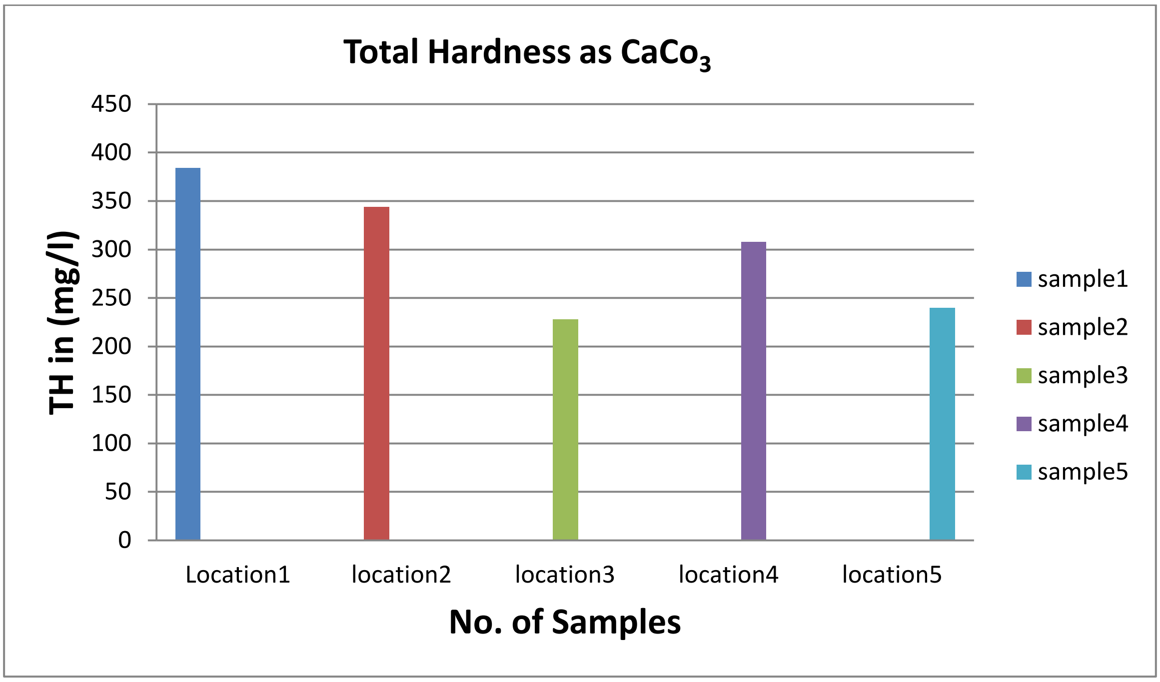

Figure 4.6 The variation of Total Hardness, locality of Rauza gaon village and Tanda khulasa

4.2.5 Calcium

The calcium concentration of different sample observed ranges from 32 to 46.5 mg/L all the sample calcium concentration within the Requirement limits (Acceptable limit)

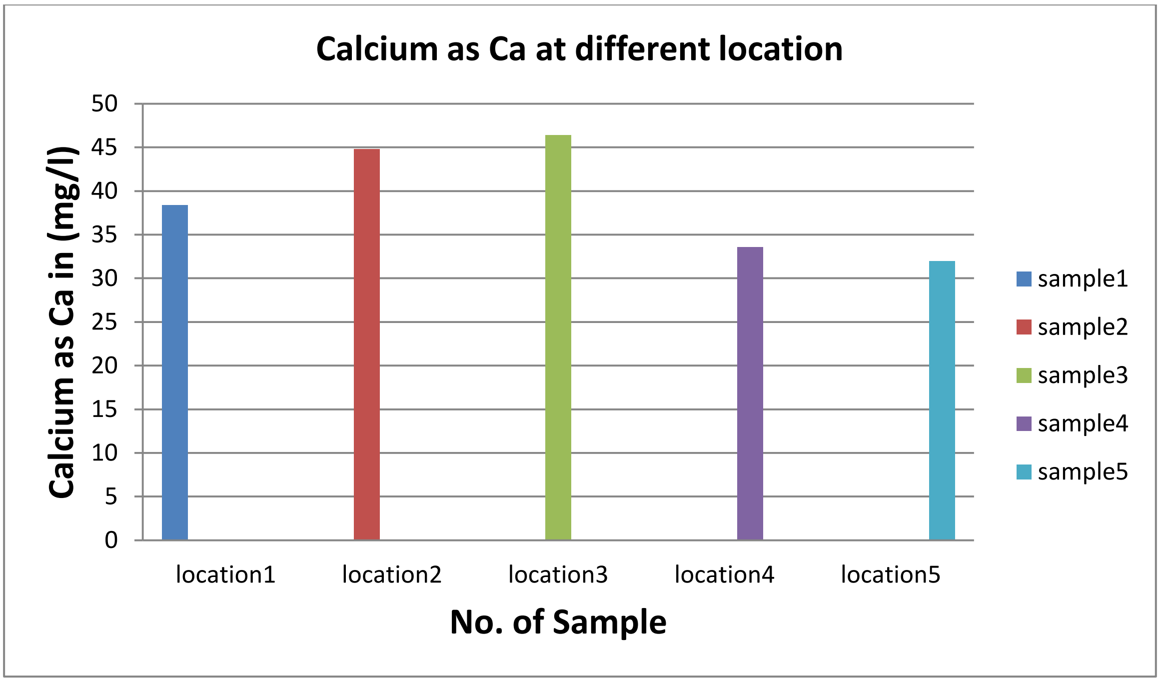

Figure 4.7 The variation of Calcium, locality of Rauza gaon village and Tanda khulasa

4.2.6 Magnesium

The magnesium concentration observed value ranges from 27.2 to 70 mg/L The only one sample within the Requirement (Acceptable limit) and sample 1,2,4, and 5 exceed the Requirement limit (Acceptable limit)

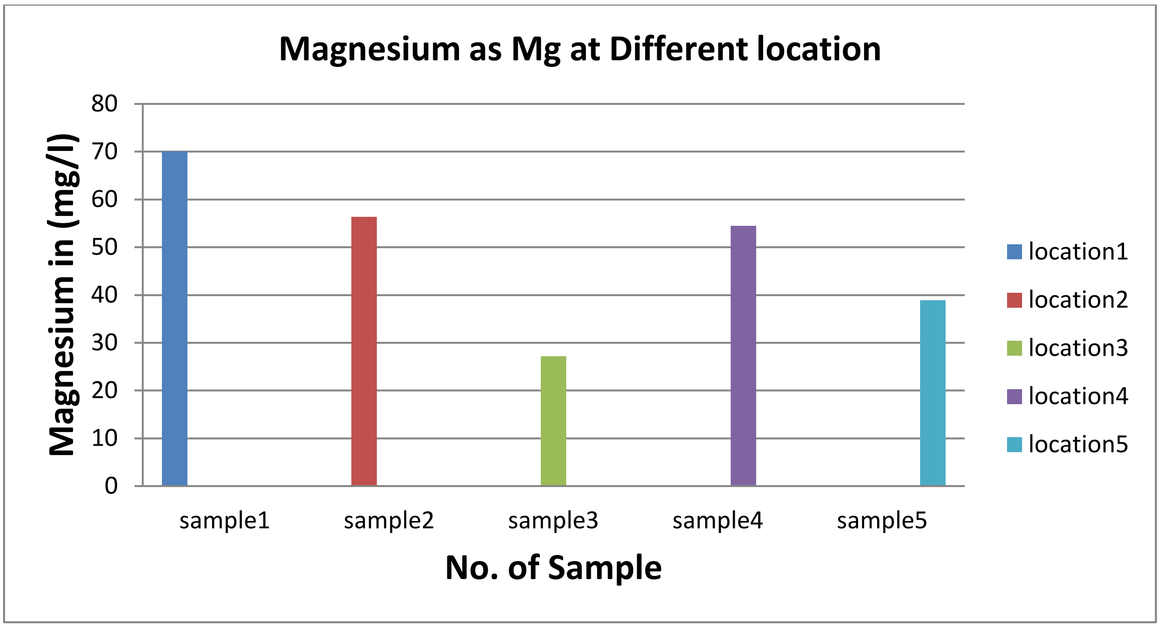

Figure 4.8 the variation of Magnesium, locality of Rauza gaon village and Tanda khulasa

4.2.7 Alkalinity

The alkalinity as (CaCo3) concentration observed in this study ranges from 232 to 364 mg/L The entire sample exceeded the Requirement (Acceptable limit) prescribed by the IS-10500 2012

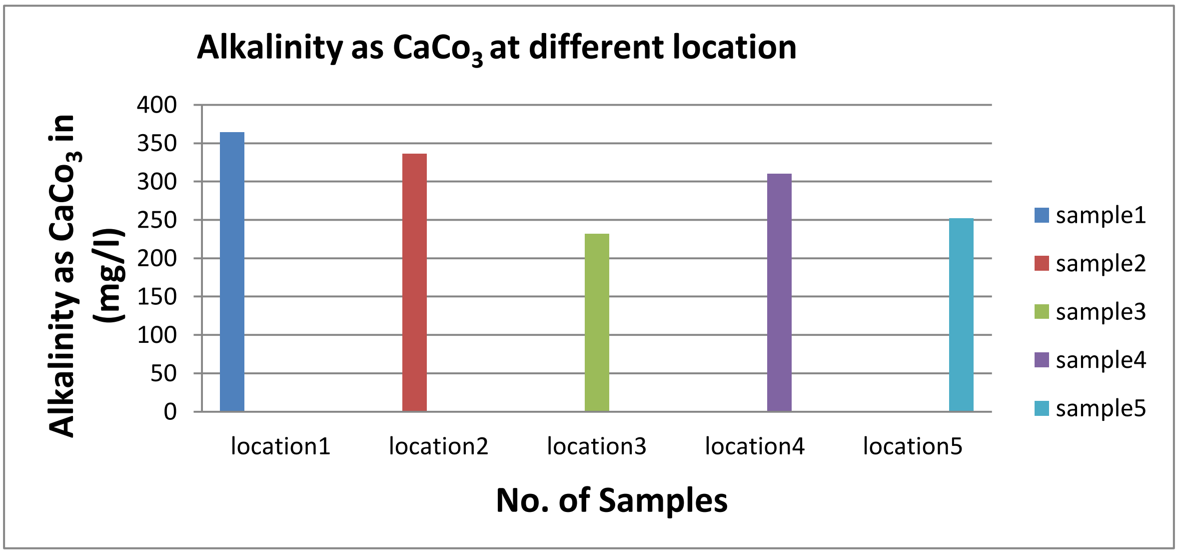

Figure 4.9 The variation of Alkalinity, locality of Rauza gaon village and Tanda khulasa

4.2.8 Chloride

Chloride concentration of the groundwater samples in the study area are varied from 12 to 48 mg/L the entire sample within the acceptable limit prescribed by the IS-10500 2012 yet these values are well below the maximum permissible limit (1000 mg/l). Excess of chloride is due to anthropogenic activity like septic tanks effluents, usage of bleaching agents by people nearby bore well.

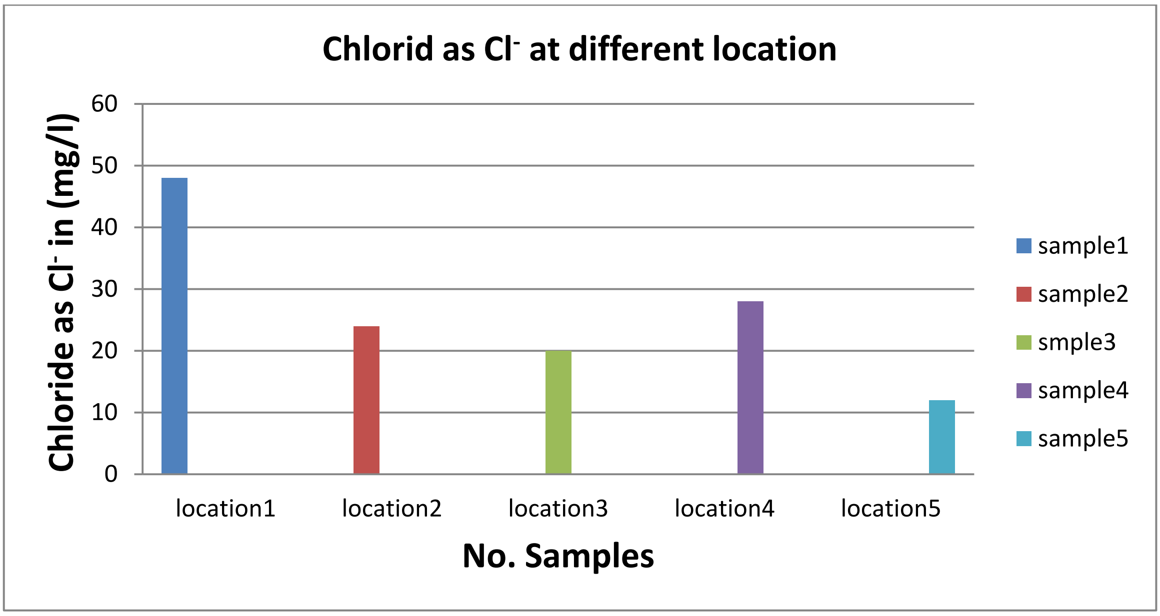

Figure 4.10 the variation of Alkalinity, locality of Rauzagaon village and Tanda khulasa

4.2.9 Sulphate

Sulphate oncentration of ground water sample observed value ranges from 13.8 to 32.8 mg/L Lessr value of within the Requirement (Acceptable limit) prescribed by the IS-10500 2012.

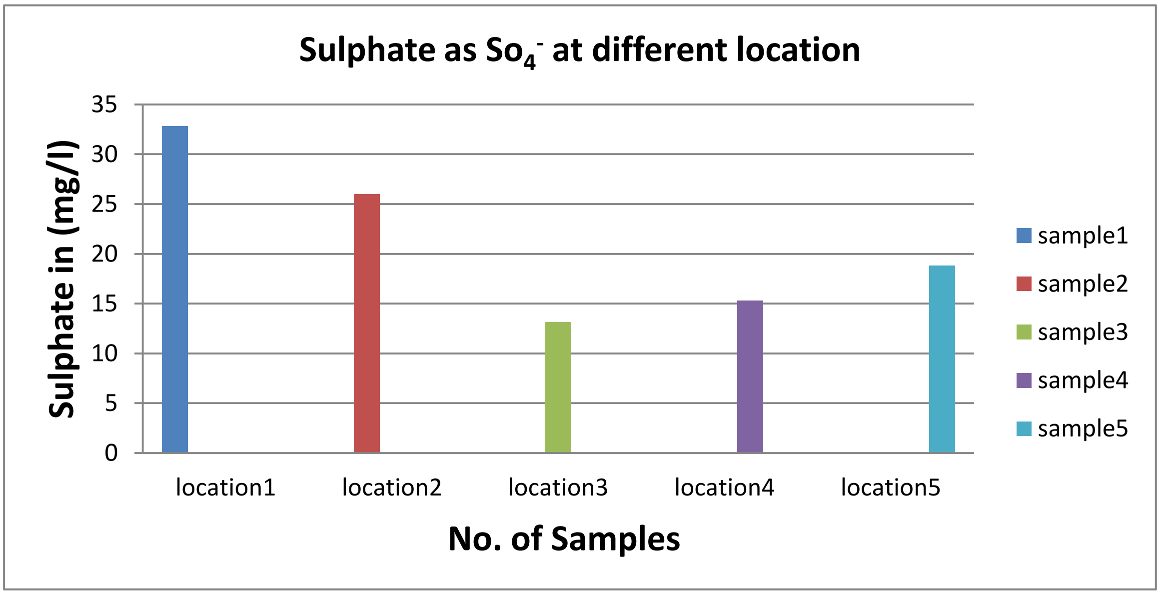

Figure .4.11 the variation of Sulphate, locality of Rauzagaon village and Tanda khulasa

4.2.10 Nitrate

The major natural source of nitrate is atmosphere, legumes, plant debris, and animal excrement nitrate varied from 1.3 to 1.9 mg/L within the acceptable limit prescribed by the IS-10500 2012 High values of nitrate concentrations results are due to solid waste from sewage and septic tanks

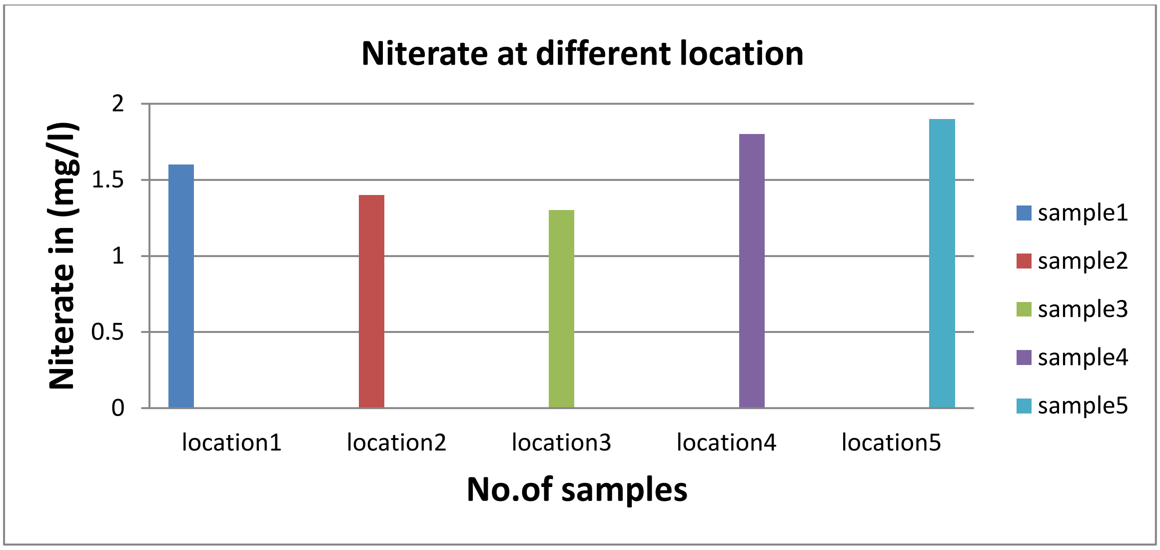

Figure 4.12 the variation of niterate, locality of Rauzagaon village and Tanda khulasa

4.3 Water Quality Index

The variation of water quality index first location near rauzagaon village sugar mill 144.82 and second location at 200m.radius water quality index found 130.3 and third location 500 m radius from centre found 88.76 the fourth ground water sample 2km from centre at Tanda khulasa found 118.215 and Fift ground water sample result 4km from the centre at Tanda khulasa village found that 95.59 which show that very poor water quality status and highly polluted ground water. The computation of (WQI) given in table 4.7

Table 4.7: Computed average WQI values for the Rrauzagaon village Radius of sugar mill

S.NO.	Param-eters	Observed value (v)	Standard (s)	Ideal I(i)	Sub index (q)	Unit weight(w)	qw	WQI
1	pH	7.05	8.5	7	3.333333	0.219	0.73	144.8453
2	EC	1144	300	0	381.333	0.371	141.4747	
3	TDS	744	500	0	148.8	0.0037	0.55056	
4	TA	364	120	0	303.333	0.0155	4.701667	
5	TH	384	300	0	128	0.0062	0.7936	
6	Ca	38.4	75	0	51.2	0.025	1.28	
7	Mg	70	30	0	233.333	0.061	14.23333	
8	Cl	48	250	0	19.2	0.0074	0.14208	

9	So_4	32.8	150	0	21.86667	0.01236	0.270272	
10	No_3	1.6	45	0	4.22222	0.0412	0.173956	
11	BOD	0	5	0	0	0.3723	0	
12	SUM (W)					1.13466		
13	SUM (qw)						164.3501	

Table 4.8: Computed average WQI values for the Tanda village 3km radius of sugar mill

S.NO.	**Parameters**	**Observed value (v)**	**Standard (s)**	**Ideal (i)**	**Sub index (q)**	**Unit weight(w)**	**qw**	WQI
1	pH	7.17	8.5	7	11.333333	0.219	2.482	95.5490
2	EC	748	300	0	249.33333	0.371	92.50267	
3	TDS	486	500	0	97.2	0.0037	0.35964	
4	TA	252	120	0	210	0.0155	3.255	
5	TH	240	300	0	80	0.0062	0.496	
6	Ca	32	75	0	42.666667	0.025	1.066667	
7	Mg	38.8	30	0	129.333	0.061	7.889333	
8	Cl	12	250	0	4.8	0.0074	0.03552	
9	So_4	18.8	150	0	12.53333	0.01236	0.154912	
10	No_3	1.9	45	0	4.22222	0.0412	0.173965	
11	BOD	0	5	0	0	0.3723	0	
12	SUM (W)					1.13466		
13	SUM (qw)						108.4157	

4.3.1 Variation of water quality index (WQI)

Rauzagaon three sample the value of (WQI) are 144.8211,130.2978,this is greater than 100 and 88.6635 which is less than 100which show that two sample result very poor quality of water and third result fairly good.

Tanda khulasa village (WQI) report maximum 118.215 and min 95.54906 which show that very poor water quality.

The physico-chemical value most of the sample parameter like TDS, TH, Magnesium, alkalinity, exceed the requirement (Acceptable limit) the variation of water quality index (WQI) Shown in fig 4.13.

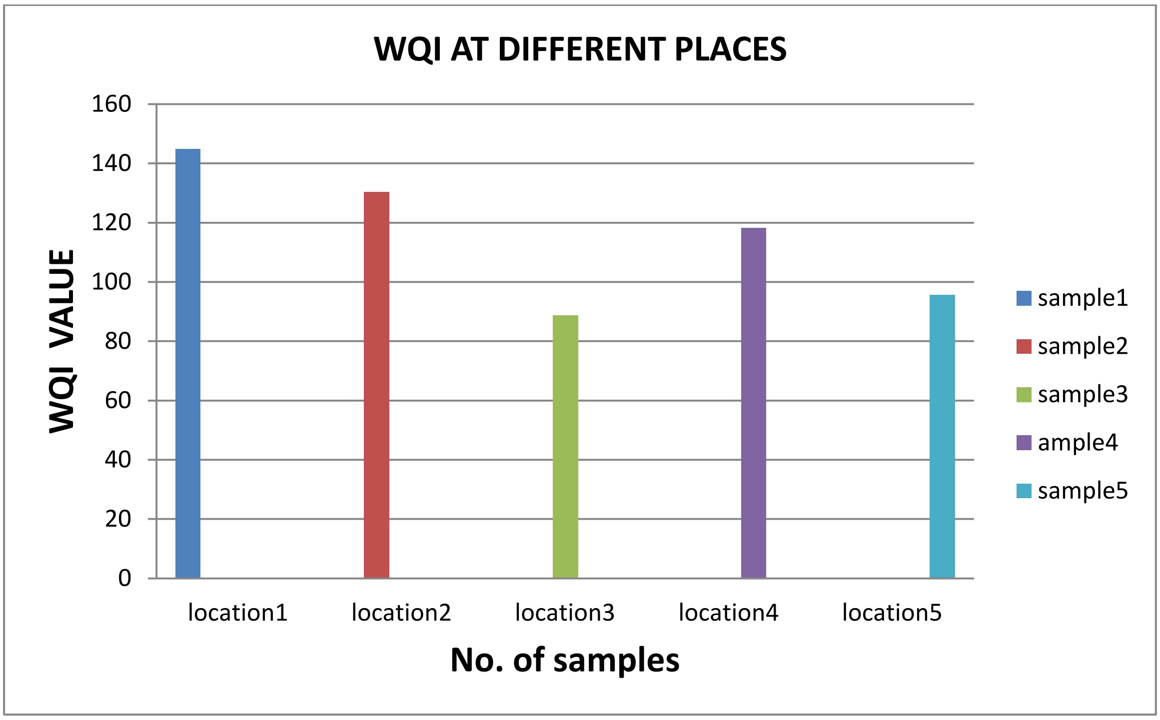

Figure 4.13 the variation of water quality index (WQI) at Different places

The high value of WQI has been found to be mainly from the higher values of turbidity, TDS, Total Hardness, magnesium, Alkalinity, which is exceeded the Requirement (acceptable limits). Prescribed by Bureau of Indian standard (IS-10500)

CHAPTER-V

CONCLUSIONS

5.0 General

Nature gives human two natural resources water and air and available free without any help of work. Out of these water plays vital role in controlling vital organs oh human body this precious resource has self attitude to convert renewable resource into a non-renewable one. Severe shortage of water due to both meteorological and anthropogenic factors has resulted in water being a commercial commodity for business.

Water is a basic human need and a precious national asset. So its use needs appropriate planning, development and management [53]. Deteriorating water quality threatens human health and the functioning of aquatic ecosystems. Adequate water quality and quantity are essential for socio – economic growth and the improvement in the quality of life [57].

For effective maintenance of water quality continuous monitoring of quality parameters and appropriate control measures are important to control the water chemistry [58]. It is continuously observed that the results of environmental interventions through public health education are based on communal campaigns for improving household and community sanitation in rural areas [59].

Access to safe drinking water, thereby reducing the burden of water borne diseases, requires a prior understanding of the intricate relationship that exists between safe drinking water and human health issues [60]. Proper understanding of status of the groundwater is important in order to meet the increasing demand of water, to formulate future development and management strategies [61].

Every use of water requires a certain minimum quality of water with regard to the presence of dissolved and suspended material of both chemical and biological nature. We can minimize the risk of groundwater contamination and the importance of groundwater should be implemented through public awareness programs. Awareness programme in any study plays a vital role to understand the prevailing status of that particular subject matter in the area. The survey taken in the study would provide valuable information which improves the quality of water in Jaipur city and its agglomerates.

The objective of this study was planned to monitor the quality of ground water consumed by urban and rural population of Rauzagaon village ndd Tanda khulasa for drinking purpose and the impact of the quality of water on their health. Groundwater flow has a complex dynamic property due to solution is not trivial which needs vis to vis solution of complicated geochemical and hydrological equations [62].

Study of ground water indicates that pollution of ground water is due to extraction of ground water through tube well which great suction of impure surface water into aquifer [63]. All above studies seems to attribute groundwater hydrochemistry to rock–water interactions, and modulated by other intervening effects. It provides helpful information on the right treatment methods to be applied earlier to practice [64]. The spatial and temporal variations in some study area indicate the leaching of contaminants from percolation of contaminants and the landfill to the groundwater aquifer system [65].

5.1 Summaries

With a concern to provide useful information to the planners with regard to suitability of water supply for the fifty five mandal headquarters of Prakasam District that have been chosen, the study objectives have been defined. Subsequently in order to achieve the objectives identified,.

In order to solve the problem defined through appropriate methodology, literature review has been carried out, the outcome being fixing the scope of the problem and realization of various tasks to be carried out (section 2). Further, the literature review has enabled the identification of the methodology to be adopted at various phases of the investigation. The methods have been followed during the literature review for the determination of groundwater quality over the study area. In the methodology, section 3.1 describes the sample collection and physico-chemical analysis for eight important water quality parameters. A number of indices have been developed to summarize water quality data in an easily expressible and easily understood format. In the present study, two types of indices (WQI) are developed by using the analyzed water quality data as described in methodology (sec 3). WQI is generated by weighted arithmetic index method. of methodology carried out the drinking suitability study for the selected area

Thus during the present study, the following field studies have been taken up for justifying the above suitability.

1. Measurement of latitude and longitude are of the stations using GPS.
2. Collection of water samples in pre and post monsoon seasons from the selected Stations.
3. Fourteen important physico-chemical properties for potability are analyzed for water samples using standard methods prescribed by APHA.

The results from the water quality studies are analyzed by considering five stations of Rauzagaon village and tanda khulasa radius of the sugar Mill in Rudauli Tehshil Faizabad. The study also enabled to identify the stations with different categories of water quality as per WQI and identify the pollution causing parameters

5.2 Conclusions

1. In the present study, from analysis in March 2020 the first sample result show that the parameter like turbidity TDS, Total, Hardness, Magnesium, alkalinity slightly vary the Requirement (acceptable limit) and remaining parameter within the acceptable limit The reason can be attributed to increase in concentration as a result of greater leaching and percolation of contaminants and decrease in concentration as a result of dilution.
2. The second sample result show that the parameter like TDS,Total, Hardness, Magnesium , alkalinity slightly vary the Requirement (acceptable limit) and remaining parameter within the acceptable limit
3. The third ground water sample observed that the parameter like Total, Hardness, alkalinity slightly vary the Requirement (acceptable limit) and remaining parameter within the acceptable limit
4. The fourth ground water sample observed that the parameter like TDS,Total, Hardness, Magnesium , alkalinity slightly vary the Requirement (acceptable limit) and remaining parameter within the acceptable limit
5. The fifth ground water sample observed that the parameter like Total, Hardness, Magnesium, slightly exceed the Requirement (acceptable limit) and remaining parameter within the acceptable limit
6. The final output has been given in the spatial representation of groundwater quality in the study area of Rauzagaon village. The analysis indicates that the groundwater of the study area needs some degree of treatment before consumption. The study helps to understand the quality of water as well as to develop suitable management practices to protect the groundwater sources.
7. The water quality status is assessed through Weighted Arithmetic Index method. WQI values of groundwater samples analyzed for pre and post monsoon seasons depict that there exists a narrow change in the WQI values which is not very significant with reference to potability and groundwater quality. Long-term trends In overall index values will be difficult to calculate until a few more years of data Are collected. Trends over a longer period can be assessed for individual water
8. As per WQI scale, the selected groundwater stations are classified from excellent to very poor and in certain areas even unsuitable for drinking. Highest value of WQI (144.8211) is observed at Rauzagaon village and minimum value of WQI (88.76635) at Tanda kulasa village

5.3 Recommendation

Clean water is a precious and limited vital resource needs to be protected, conserved and used wisely by man. Every effort should be made to achieve a drinking water quality as safe as practicable the quality of drinking water is powerful environmental determinant of human health. Assurance of drinking water safety is a foundation for the prevention and control of water borne diseases and health hazards due to chemicals present in water. Research work indicates that ground water chemistry in study area of rauzagaon village and tanda khulasa are under severe pollution threats. The chemical hazards to drinking water may pose possible risks of long term even of chronic human health problems. If preventive measures are not taken for drinking water by statutory authorities otherwise the problem becomes more adverse.

Drinking water chemistry as quality concerns are now major goal of several national and international program because number of chemicals are added in the universal solvent. It cannot be achieved completely without active participation of the public including local authorities. Further, detailed studied on the health – issues of the local residents are still required to trace the impact of contaminated drinking water consumption on local residents. Lack of awareness about good sanitation and personal hygienic practices, among peoples is an important factor for poor drinking water quality in these localities. Although several national and international organizations are working to provide safe sanitation and drinking water facilities in this areas but poor education and awareness level of people are the major barriers in their success.

Human beings need quality water to maintain health with it. Whereas availability of sufficient and safe supply of drinking water available is not of that quality. Computed WQI value and optimization of water samples revealed poor quality of ground water of Rauzagaon. And tanda khulasa near the sugar mill High WQI in area has been found to be mainly because of higher values of EC, TH, TDS and alkalinity; etc .that indicated samples exhibit poor quality in great percentage. This may be due to over exploitation of ground water, direct discharge of effluents and agricultural

It is suggested that risk assessment of pollution is useful for better managing groundwater resource, preventing soil salinization and minimizing pollution in groundwater.

Research revealed major causes of poor water quality are related to inflow of effluent from domestic, agricultural industrial and seepage as in case of that localities. People from all socio-economic backgrounds and is associated with the highest co-morbidities and complications among all non-communicable diseases.

5.3.1 Artificial Recharge of Ground Water

Artificial recharge of ground water by arresting storm water run–off during monsoon seasons should be the policy directive in all localities especially of more poor quality of water. Ground water draft more than 90% of the assessed replenish able resource or areas where decline either in the Pre or Post Monsoon water levels is observed or the areas where adequate storage capacity is available.

A large scale programme for conducting feasibility studies for ground water recharge be planned and undertaken by state and central water institutions. CGWB should take up case studies & research for developing designs of recharge structures, cost – economic analysis and for generating basic parameter data – base in different areas for the purpose

5.3.2 Proposed Treatment Techniques for Better Chemistry of Ground Water

Here municipalities can consider the use of different treatment methods it pays more effective, safe water for the public may be as

(i) Physical Methods: Use of ecofriendly filters. Further need to develop RO system with higher product capacity to feed of 600ppm TDS raw water. The required water should be around 120-140 ppm.

.(ii) Use of Chemical Methods in which quantity of chemical additions are theoretic and that can be variable depending on local quality and other considerations in all is not in the right concentration you are. In some locations this technology could be expensive and be careful to for selection of the right chemicals for it. (iii) Biochemical Methods: Bioremediations are important treatment and more environmentally friendly. Herbs and Plants are also important concerns.

5.3.3 Proper Disposal of Domestic Solid Wastes and Industrial Wastes

Disposal of solid wastes in natural or man – made depressions without adequate scientific considerations is bound to pollute ground water in due course. As a measure of precaution, it is essential that solid waste in Rauzagaon village and nearby area should be disposed off in scientifically located and designed sites and structures for recycling and reuse. Detailed investigations to locate such sites must be initiated urgently.

Impact of the release of industrial waste in an unsystematic manner and without pre – disposal treatment is causing deterioration in ground water quality. The liquid waste from the Sugar industry near rauzagaon is leading to an increase physico-chemical concentration in ground water Urgent measures including awareness and punitive action may have to be taken to contain further degradation in the quality.

REFERENCES

[1] Hakim M.A., A.S. Jslraimi, M. Begum, M, Hafanuzzaman, M.K. Uddin and M. Islam, "Suitability Evaluation of Groundwater for Irrigation, drinking and Industrial Purposes in chiribandar in Dinajpur District of Bangladesh*", American Jr. of Envi. Sciences*, Vol. 5(3), pp 413-419. (2009)

[2] Sundara Kumar. P., Sundara Kumar. P., Dr. M.J. Ratnakanth Babu and Dr. Ch.Hanumantha Rao, "Assessment and Mapping of Groundwater Quality Using Geographical Information *Systems International Journal of Engineering Science and Technology*", Vol. 2(11), pp.6035-6046. (2010)

[3] Nageswara Rao, K., Narendra K., and Venkateswarlu P., "Assessment of groundwater quality in Mehadrigedda watershed, Visakhapatnam district, Andhra Pradesh, India: GIS approach", *Journal of Pollution Research*, 26(3), pp 1526. (2007)

[4] Goel, P.K. and Sharma, K.P., "Environmental guidelines and standards in India", *Technoscience Publications*, Jaipur, India. (1996)

[5] Meenakshi and Maheshwari R. C. (2006) J. of Hazardous Matter,**137(1)**; 456-463.

[6] UNEP (1999) Global Environment Outlook 2000, Earthscan, London.

[7] Fetter, C. W. (1994) Applied Hydrogeology**,** Third Eddition. Prentice Hall, New Jersy.

[8] Umar, R., Muqtada, M., Khan, A. and Absar, A. (2006) *Environ.Geol.*, **49**; 999-1008.

[9] Zuane, J. D. (1990) Drinking Water Quality: Standards and Control,Van Nostrand Reinhold, New York.

[10] Kundell, J. (2008) Water Profile of Malawi. Food and Agriculture Organisation.

[11] Tiwari, T. N. and Ali, M. (1988) Water Quality Index for Indian Rivers. In Ecology and Pollution in Indian Rivers. Ashish Publishing House, New Delhi, 271-286.

[12] Mawulikwame, M. (2011) Ph. D. Thesis (Unpublished), Department of Theoretical and Applied Biology, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

[13] BIS (2012) Bureau of Indian Standards, Indian Standards specification for drinking water IS10500, 2012.

[14] ICMR (1975) Indian Medical Council of Medical Research, Manual of Standards of quality of drinking water.

[15] WHO (2006) Guidelines for Drinking Water Quality, first Addendum to the third edition, Recommendations. Geneva, **1**.

[16] Pejman A H, Bidhendi G R, Mehrdadi N, Karbassi A R and Esmaeili B M " Evaluation of Spatial and Seasonal variation in Surface water Quality using Multivariate Statistical Techniques " *Int.J.Env.Science.Tech*., 6(3),467-476 (2009).

[17] Joseph A R " Principles and Practices of Water Supply Operations –Water Quality " 4th Edition ,American Water Works Association (**2003**).

[18] Karun K,Thamilarusu, P and Sharmila R " Statistical Study on Physicochemical Characterstics of Groundwater in and around Namakkal, Tamilnadu, India" *E Journal of Chemistry,* **6** (3), 909-914, (**2009**).

[19] Meena A K, Rajagopal C, Bansal P and Nagar P N " Analysis of Water Quality Characterstics in Selected areas of Pali District in Rajasthan" *Indian Journal of Environment Protection,* **29** (11), 1011 -1016 (**2009**).

[20] Chhipa R C, Keynote Address On "Bioremediation As Separation Of Toxic Metals From Polluted Water" in All India Seminars on „Emerging Trends and Sustainable Technologies for Separation Process in Chemical and Allied Industries‟ on 28-29 July 2007 at The Institution of Engineers (India), Jaipur .

[21] Guidelines for Drinking-Water Quality WHO, 3rd Edition, incorporating First and Second Addenda (**2004**).

[22] Joarder M A M, Raihan F, Alum J B and Hasanuzzaman S "Regression Analysis of Ground Water Quality data of Sunamganj District, Bangladesh" Int. J. Enviorn. Res., 2(3), 291-296 (2008).

[23] Tatawat R K and Chendel C P S " A hydro chemical profile for assessing the Groundwater Quality of Jaipur City" *Environ Monit. Assess.,* **143,** 337-343(**2008**).

[24] Hammer M J and Hammer M J "Water and Wastewater Technology" 6th Edition, Pearson Education, Inc. New Jersey U.S.A (**2008**).

[25] Matinilaurent and Moutou J M "Ground Water Quality of Southeastern Brazzaville, Congo" *E –Journal of Chemistry,***7** (3), 861-869 **(2010**).

[26] Salve P R, Maurya A, Kumbhare P S, Ramteke D S and Wate S R " Assessment of Ground water Quality with respect to Fluoride " *Bull Environ. Contam Toxicol,.* **81**, 289-293 (**2008**).

[27] Sunitha V, Reddy M R and Sudarsana R G " Fluoride Contamination in Groundwater of Uravakonda and its Correlation with other Water Quality Parameters ,Anantapur District, Andhra Pradesh" *Indian Journal of Environment Protection* **29**(5), 451-460 (**2009**).

[28] Joshi A and Seth G "Hydrochemical Profile for Assessing the Groundwater Quality of Sambhar lake city and its adjoining area" *Environ. Monit. Assess.*,**174** (1-4) 547-554 (**2010**).

[29] Adekunle I M, Adetunji M T, Gbadebo A M and Banjoko O B "Assessment of Ground Water Quality in a typical Rural settlement in Southwest Nigeria" *International Journal of Environmental Research and Public Health*, **4** (4) 307-318 (**2007**).

[30] Meena A K, Rajagopal C, Bansal P and Nagar P N " Analysis of Water Quality Characterstics in Selected areas of Pali District in Rajasthan" *Indian Journal of Environment Protection,* **29** (11), 1011 -1016 (**2009**).

[31] Hameed A, Alobaidy M J, Abid H S and Maulood B K " Application of Water Quality Index for Assessment of Dokan Lake Ecosystem, Kurdistan Region, Iraq" *Journal of Water Resource and Protection,* 2 (9), 792-798, (2010).

[32] Yisa J and Jimoh T "Analytical Studies on Water Quality Index of River Landzu, Nigeria " *American Journal of Applied Sciences,* **7** (4), 453-458 (**2010**).

[33] Wujianehua, Lipeiyue and Qianhui " Ground water Quality in Jingyuan Country" a Semi-Humid Area in Northwest China" *E – Journal of Chemistry,* **8**(2) ,787-793(**2011**).

[34] Shankar S and Latha S "Assessment of Water Quality Index for the Ground water of an Industrial area in Bangalore ,India " *Environ. Eng. Sci.*, **25**(6), 911-916 (**2008)**.

[35] Chaturvedi M K and Bassin J K "Assessing the Water Quality Index of Water Treatment Plant and Bore wells, in Delhi , India " *Environ . Monit. Assess.,* **163** (1-4), 449-453 (**2010**).

[36] Saeedi M, Abessi O, Sharifi F and Meraji H " Development of Ground Water Quality Index " *Environment Monitoring Assessment* **163,**327-335 (**2010).**

[37] Shindu S K and Sharma A " Study on some Physico –Chemical Characterstics of Ground water of District Rampur –A Statistical Approach " *E – journal of chemistry,* **44(**2),162-165 (**2006**).

[38] Brown R M, Cleiland N J Mc, Deiniger R A, and O‶ Connor M F A "Water quality index – crossing the physical barrier" (jenkins shed) proc. *intl. conf. on water poll. res. Jerusalem,* 6, 787 – 797 (1972).

[39] Bharti N and Katyal D "Water Quality Indices used for Surface Water Vulnerability Assessment" *International Journal of Environmental Science,* **2** (1), 154-172(**2011**).

[40] Saeedi M, Abessi O, Sharifi F and Meraji H " Development of Ground Water Quality Index " *Environment Monitoring Assessment* **163,**327-335 (**2010).**

[41] Said A, Stevens D K and Sehlke G "An Innovative Index for Evaluating Water Quality in Streams" *Environmental Assessment,* **34 (**3),406-414 (**2004**).

[42] Debels P, Figueroa R, Urrutia R, Barra R and Niell X " Evaluation of Water Quality in the Chillán River (Central Chile) Using Physicochemical Parameters and a Modified Water Quality Index" *Environmental Monitoring and Assessment*, 110 (1-3), 301-322 (2005).

[43] Puri P J, Yenkie M K N, Sangal S P, Gandhare N V, Sarote G B,and Dhanorkar D B " Surface Water (lakes) Quality Assessment in Nagpur City (India) based on Water Quality Index (WQI)" *Rasayan Journal of Chemistry*,**4** (1),43-48 (**2011**).

[44] Kumar, S., Kumar, M., Kumari, A., Kumar, A. and Singh, A. (2017). Effect of Sugar Mill Effluents on Ground Water Quality. *International Journal of Current Microbiology and Applied Sciences,* 6(12), pp.169-176.

[45] A. Yadav and R. Daulta, “Effect of Sugar mill on Physico-Chemical Characteristics of Groundwater of Surrounding Area.” *International Research Journal of Environment Sciences* 3(6), 62-66, June 2014.

[46] M. C. Agale, N. G. Patel and A. G. Patil, "Impact of sugar industry effluents on the quality of groundwater from Dahiwad Village, Dist-Dhule(M.S.*)." Archives of Applied Science Research*, 5 (2), 58-60, 2013

[47] Kawade, A. and Gadhave, P. (2015). Portability of Ground Water from Areas around a Cane- Sugar Industry: A Case Study. *International Journal of Environmental Science and Development*, 6(2), pp.147-150.

[48] M. Sharma and S. Chaudhry, “Assessment of Ground Water Quality in Vicinity of Industries and along Yamuna River in Yamuna Nagar, Haryana, India.” *Asian Journal of Science and Technology,* 4(10), pp.054-061 October 2013.

[49] R. Yadav, J. K. Wahane And O.N. Choubey, “Impact Of Sugar Industry Effluents On The Quality Of Groundwater Near Bankhedi Sugar Industry Dist. Narsinghpur (Mp) India.” *Journal of Industrial Pollution Control,* July 2015.

[50] J. Srinivas, A.V. Purushotham and K.V.S.G Murali Krishna, “Determination of Water Quality Index in Industrial areas of Kakinada, Andhra Pradesh, India.” *International Research Journal of Environment Sciences,* 2(5), 37-45, May (2013).

[51] Vipin Kumar Swaroop, N.B. Singh and Apoorv Verma, Assessment of Groundwater Quality Using Water Quality Index in Unnao District, Uttar Pradesh, India. *International Journal of Civil Engineering and Technology*, 9(8), 2018, pp. 155-165.

[52] Shivasharanappa and et al, Assessment of Ground Water Quality using Water Quality Index, at Bidar City Karnataka, *International Journal of Environmental Science*, 2(2), 965-976 (2011)

[53] G. Matta, R. Kumar, A. Kumar, and A. Kumar, "Effect of industrial effluent on groundwater quality with special reference to DO, BOD and COD." *Journal of Sustainable Environmental Research*, 3 (2), 183-186, December 2014.

[54] P.B. Lokhande, S.M. Tandale, H.A. Mujawar, “Evaluation of Ground Water Quality of M. I. D. C. Area, Roha through Water Quality Index Assessment.” *International Journal of Scientific& Engineering Research*, 5(4), 2229-5518, April (2014).

[55] David, N. and Rajan, M., 2014. Impact of Dyeing Industry Effluent on Groundwater Quality by Water Quality Index and Correlation Analysis. *Journal of Pollution Effects & Control*, 02(02).

[56] Massoud A M “Assessment of water Quality along a Recreational section of the Damour river in Lebanon using the Water Quality Index ” *Environmental Monitoring and Assessment,***184** (7), 4151-60 (**2010**).

[57] Bhandari S N and Nayal K “ Correlation Study on Physico- Chemical Parameters and Quality Assessment of Kosi River Water , Uttarkhand ” *E- Journal of Chemistry,* **5** (2), 342-346 (**2008**).

[58] Adekunle I M, Adetunji M T, Gbadebo A M and Banjoko O B "Assessment of Ground Water Quality in a typical Rural settlement in Southwest Nigeria" *International Journal of Environmental Research and Public Health*, **4** (4) 307-318 (**2007**).

[59] Suthar S "Contaminated Drinking Water and Rural Health perspectives in Rajasthan, India: an overview of recent case studies" *Environmental Monitoring and Assessment, 173*(1-4) 837-49, (**2010**).

[60] Jasmin I, Murali T and Mallikarjuna P " Statistical Analysis of Groundwater Table Depths in Upper Swarnamukhi River Basin " *J. Water Resource and Protection* **2**, 577-584(**2010).**

[61] Dash J R, Dash P C and Patra H K " A Correlation and Regression study on the Ground water Quality in Rural Areas Around Angul Talcher Industrial Zone " *Indian J. Environmental Protection,* **26** (6),550-558 (**2006**).

[62] Reza R and Singh G "Assessment of River Water Quality Status by using Water Quality Index (WQI) in Industrial Area of Orissa" *International Journal of Applied Environmental Sciences,* **5** (4), 571–579 (**2010**).

APPENDICES


IJMTE
International Journal of Management Technology and Engineering
An ISO : 7021 - 2008 Certified Journal
ISSN NO: 2249-7455 / web : www.ijamtes.org / e-mail : submit@ijamtes.org
Address : A14/7- UA, Armament, Pune, India - 411021

CERTIFICATE OF PUBLICATION

Certificate ID : IJMTE/3327

This is to certify that the paper entitled

"Effect of Sugar Industry Effluent on Ground Water Quality: A Review"

Authored by

Waris Ali Ansari

From

Babu Banarsi Das University, Lucknow

Has been published in

IJMTE JOURNAL, VOLUME X, ISSUE VI, JUNE - 2020

URKUND

Document Information

Analyzed document	thesis report waris.docx (D75596262)
Submitted	6/25/2020 7:27:00 AM
Submitted by	Mr kamal Nath Tripathi
Submitter email	kamalnt11@bbdu.ac.in
Similarity	11%
Analysis address	kamalnt11.bbduni@analysis.urkund.com

Sources included in the report

SA	**447_Viral_Zoology.pdf** Document 447_Viral_Zoology.pdf (D50856494)	4
SA	**Seasonal studies on the physico chemical characteristics and heavy metal content i ...** Document Seasonal studies on the physico chemical characteristics and heavy metal content i ... (D40568912)	1
SA	**Full thesis aligned BB 26-04-2081.docx** Document Full thesis aligned BB 26-04-2081.docx (D38002059)	1
SA	**Thesis.docx** Document Thesis.docx (D40561685)	11
W	URL: https://www.researchgate.net/publication/280830080_ASSESSMENT_OF_GROUND_WATER_QUAL... Fetched: 6/10/2020 9:38:21 PM	12
SA	**ThesisPhD. Jyoti Jadon JVD101017 Jayoti Vidyapeeth Women's University, Jaipur (Raj ...** Document ThesisPhD. Jyoti Jadon JVD101017 Jayoti Vidyapeeth Women's University, Jaipur (Raj ... (D29572095)	1
SA	**ARO 17.5.18 NEW3.docx** Document ARO 17.5.18 NEW3.docx (D38762045)	5
SA	**rachna yadav chemistry.docx** Document rachna yadav chemistry.docx (D55499997)	6
SA	**full thesis on 2.6.18.docx** Document full thesis on 2.6.18.docx (D39992083)	11
W	URL: https://www.researchgate.net/profile/Arvind_Swarnakar/publication/292970894_Analys ... Fetched: 12/13/2019 8:44:16 AM	2
SA	**Mahmoodah Parveen - Ph.D Thesis.pdf** Document Mahmoodah Parveen - Ph.D Thesis.pdf (D63025688)	4
	Water quality index development for groundwater quality assessment of Greater Noida sub-basin, Uttar Pradesh, India	

BBDU-PG- FORM 01

BABU BANARASI DAS UNIVERSITY, LUCKNOW

CERTIFICATION OF FINAL THESIS SUBMISSION

(To be submitted in Duplicate)

1. Name: ………………………………………………………………………………..
2. Enrollment No. ……………………………………………………………………....
3. Thesis Title: ………………………………………………………………….................

   ………………………………………………………………………………………..

   ………………………………………………………………………………………..
4. Degree for which the thesis is submitted: ……………………………………………...
5. Faculty of the university to which the thesis is submitted: …………………………......

   ………………………………………………………………………………………..
6. Thesis Preparation Guide was referred to for preparing the thesis. [ ] YES [ ] NO
7. Specification regarding thesis format have been closely followed. [ ] YES [ ] NO
8. The contents of thesis have been organized based on the guideline. [ ] YES [ ] NO
9. The thesis has been prepared without resorting to plagiarism. [ ] YES [ ] NO
10. All sources used have been cited appropriately. [ ] YES [ ] NO
11. The thesis has not been submitted elsewhere for a degree. [ ] YES [ ] NO
12. All the corrections have been incorporated [ ] YES [ ] NO
13. Submitted three hard bound copies plus one CD [ ] YES [ ] NO

(Signature of the candidate)

Name ……………………………….

Roll No: ……………………………

Enrollment No: ….……………........

BBDU-PG- FORM 02

BABU BANARASI DAS UNIVERSITY, LUCKNOW

CERTIFICATION OF FINAL THESIS SUBMISSION

(To be submitted in Duplicate)

1. Name:…………………………………………………………………………………..
2. Enrollment No. ………………………………………………………………………..
3. Thesis Title: ……………………………………………………………………................

   ………………………………………………………………………………………

   ………………………………………………………………………………………
4. Degree for which the thesis is submitted: ……………………………………………..
5. Faculty of the university to which the thesis is submitted: …………………………......

   ………………………………………………………………………………………
6. Thesis Preparation Guide was referred to for preparing the thesis. [ ] YES [ ] NO
7. Specification regarding thesis format have been closely followed. [ ] YES [ ] NO
8. The contents of thesis have been organized based on the guideline. [ ] YES [ ] NO
9. The thesis has been prepared without resorting to plagiarism. [ ] YES [ ] NO
10. All sources used have been cited appropriately. [ ] YES [ ] NO
11. The thesis has not been submitted elsewhere for a degree. [ ] YES [ ] NO
12. All the corrections have been incorporated [ ] YES [ ] NO
13. Submitted three hard bound copies plus one CD [ ] YES [ ] NO

(Signature of supervisor) (Signature of the candidate)

Name ……………………………….

Name: ……………………………… Roll No: …………………………...

Enrollment No: ….………………......