PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER FROM TWO TALUKAS (BHARUCH AND ANKLESHWAR) OF BHARUCH DISTRICT

A Thesis

Submitted for the Award of Ph.D. Degree of

PACIFIC ACADEMY OF HIGHER EDUCATION AND RESEARCH UNIVERSITY

By

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CERTIFICATE

It gives me immense pleasure in certifying that the thesis entitled **"PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER FROM TWO TALUKAS (BHARUCH AND ANKLESHWAR) OF BHARUCH DISTRICT"** submitted by **BHAVIN P. PATELIYA** is based on the research work carried out under my guidance. He has completed the following requirements as per Ph.D. regulations of the University;

(i) Course work as per University rules.

(ii) Residential requirements of the University.

(iii) Regularly presented Half Yearly Progress Report as prescribed by the University.

(iv) Published/ accepted minimum of two research paper in a refereed research journal.

I recommend the submission of thesis as prescribed/ notified by the University.

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DECLARATION

I, **BHAVIN P. PATELIYA** S/o **Mr. PARASHOTTAMBHAI** resident of **CM-89, Opposite Lakhubha Holl, Kaliyabid, Bhavnagar, Gujarat - 364001** hereby declare that the research work incorporated in the present thesis entitled **"PHYSICO-CHEMICAL ANALYSIS OF GROUND WATER FROM TWO TALUKAS (BHARUCH AND ANKLESHWAR) OF BHARUCH DISTRICT"** is my original work. This work (in part or in full) has not been submitted to any University for the award or a Degree or a Diploma. I have properly acknowledged the material collected from secondary sources wherever required. I solely own the responsibility for the originality of the entire content.

Date :

Place:

(BHAVIN P. PATELIYA)

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PREFACE

Physico-chemical analysis of the ground water collected from the Bharuch district of Gujarat with respect to three different seasons such as Winter, Summer and Monsoon. Two talukas such as Ankleshwar and Bharuch of Bharuch district, (Gujarat) were selected for the measurement of physico-chemical parameters such as concentration of different ions like chloride, fluoride, nitrate, calcium, sulphate and magnesium, pH, Chemical oxygen demand (COD), Biological oxygen demand (BOD), total alkalinity, dissolved oxygen (DO), total dissolved solid (TDS). Analysis was done for Ankleshwar and Bharuch Taluka of Bharuch district, Gujarat with 15 different stations from each taluka. All the parameters measured were compared with the standard value for the potable water and our objective to do this is to make peoples of these regions aware in terms of quality of water they are using. Also, they will be able to do needful work to improve the quality of water. This presented doctoral thesis is also very useful for the researchers for enhancing their research work and also for the peoples who want to check the quality of potable water.

In the present work there are thirty different station from the two taluka of Bharuch district were selected as given below:

1. **ANKLESHWAR TALUKA:**

SARTHAN, TELVA, PILUDRA, UMARWADA, JETALI, PIPROD, AVADAR, PARDI MOKHA, SANGPOR, KOSAMADI, PANOLI, KHAROD, MOTALI, ANDALA AND UTIYADARA

2. **BHARUCH TALUKA:**

ADOL, AMDADA, AMLESHWAR, BAMBUSAR, BHUVA, CHOLAD, DABHALI, GHODI, HALDAR, KARELA, KELOD, OSARA, SAMLOD, SEGVA AND SHAHPURA

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CHAPTER – I

INTRODUCTION

CONTENTS

1.1 INTRODUCTION

Water is very useful and plays significant role in our life. Water that has excellent natural quality, is pathogen-free, color-free, turbidity-free, and is suitable for direct consumption without treatment. Ground water is becoming more significant as surface water becomes more contaminated. It has unique qualities that makes it especially suitable for the supply of public water[1]. To survivel, very important source for global population is the ground water and is very useful for the living organism but supplies are diminishing and it is not being preserved from degradation[2]. Groundwater overdraft has caused ecosystem damage, soil subsidence, salt water intrusion, well, spring, and canal drying up, change in groundwater quality, and finally damage to the aquifers[3]. Reviewing and assessing the variables affecting surface and groundwater as well as suggesting solutions to the crisis are urgently needed.

Ground water quality and ground water tables are continuously reducing because of the agriculture and urbanization waste, industrial waste, raising the possibility of quality deterioration and contaminating the aquifers that supply potable ground water. Pesticides and insecticides have been overused and heavily applied, contaminating the subsurface environment and rendering many sources unusable[4]. When contaminants spread over large areas of the aquifer, ground water becomes unfit for use in a variety of applications. Soil salinity is one of the most crucial elements that influences agricultural production, particularly in irrigated arid areas. Anthropogenic and geological processes are also attributes for the huge level of arsenic mineral and fluoride in the potable and ground water[5].

In coastal areas, salt water intrusion pollutes aquifers that supply potable ground water. A shortage of drinking water, a reduction in the amount of land planted, a decrease in the yield per hectare, and risks to human and animal health have all been brought on by the rise in salinity. Seawater intrusion into the water table has been caused by excessive groundwater extraction in coastal areas, which has been primarily supported by agricultural growth[6]. The regulation of the natural discharge is appropriate as groundwater development proceeds. To account for natural discharge during non-monsoon seasons, some consideration for future development must be given when calculating the amount of groundwater available[7]. Rainwater harvesting is a valuable alternative and supplemental water resource method that has regained importance. Before it is lost as surface runoff, rainwater can be collected and stored on the surface or in subsurface aquifers using the rainwater harvesting technique. One can use the enhanced resource whenever it is needed. A variety of methods and tactics may be investigated when a rainwater harvesting system is developed.

An ancient technique for gathering water that is crucial to the local and regional hydrological cycle is rainwater harvesting[8]. It is primarily used in dry environments, and several nations have acknowledged it as a practical decentralized water supply[9]. Aquifers can be replenished either naturally or artificially. Rainwater or surface water will inevitably percolate into shallow and deep aquifers if an aquifer recharges naturally. By using a properly designed and built structure to transfer runoff water from the Earth's surface to an aquifer that is accessible at any depth, rainwater harvesting can artificially boost recharge[10]. Alternative methods for collecting rainfall in densely populated cities and coastal areas include collecting water in reservoir and ponds, using bore hall were to recharge ground water sources and direct infiltration. These methods are in addition to individual rainwater harvesting systems. Infiltration describes the process by which water from irrigation or rainfall enters the soil. If permeable soil is not available, water can be injected directly into aquifers through trenches, wells, and shaft in unsaturated zones for artificial recharge. The determination of infiltration rates of the soil is necessary to check the adequate permeability and absence of polluted areas[11]. The design of a harvesting of rain water body depends on the lithology, hydrometry, and land use of the particular location. Rain water harvesting has been neglected due to the improvements in the technological which, paved and built urban areas in many developed countries which resulted in reduction of groundwater recharge area. Industrial, agricultural, and urban wastes that leach or are injected into underlying aquifers have an increasing negative impact on the quality of ground water. It has been demonstrated that pollution can spread widely over many years after entering the subsurface environment. Therefore, areas of groundwater aquifer and render groundwater supplies unfit for use in drinking water and other applications. In the nation's largest cities and towns, the rate of ground water depletion and the decline in its quality are causes for concern. The quality and quantity of ground water are significantly impacted by the local climate, topography, geological formations, and use and abuse of this essential resource. The quantity and quality of ground water are both improved by the use of harvested rainwater[12]. Harvesting rainwater is an environmentally friendly way to address the global water crisis and could support water management plans. Utilizing cutting-edge artificial recharge techniques, ground water restoration might help to partially alleviate the water crisis[13]. Remote sensing and geographic information systems (GIS) are being used to locate a suitable location for rainwater harvesting with the potential for ground water recharge[14]. To choose an appropriate location for artificial recharge, influencing factors must be identified, and spatial maps for each factor must be produced in a GIS platform[15]. An influential factor could be the land use, slope, depth to groundwater infiltration rate, and quality of alluvial sediments[16]. In the GIS environment, a runoff potential map can be created to supplement water collection systems[17]. The overall procedure entails digitizing charts and ground data, setting up a coordinate and projection system, creating surface maps from point data, interpreting the findings, and discussing them. Anywhere in India, a coastal groundwater basin can have its groundwater potential zones delineated[18].

The vast coastline of India is the foundation of the country's economy, and oil refineries are typically found there. These facilities frequently pollute the soil and groundwater. Some of the country's most potential aquifer systems are found in the coastal region. Assessing the sustainability of coastal groundwater is crucial for groundwater management because it is vulnerable to overuse and contamination[19]. It is challenging to manage groundwater systems effectively, as it is in many developing countries, due to a lack of hydrogeological data. Among the aquifers impacted by saltwater intrusion, those near the coast are the most productive. The use of suitable conceptual groundwater models facilitates the accurate evaluation of groundwater safety in coastal aquifers[20]. An efficient way to determine the potential zones, analyses, and evaluation of the ground water recharge capacity in coastal and industrial locations can be achieved through integrated modelling methodology.

1.2 REFINERIES OVERVIEW

An oil refinery is a type of processing plant used to turn crude oil into petroleum products like gasoline, diesel, and heating oils. Soil and groundwater are contaminated as a result of potential petroleum product leaks at various stages of the petroleum refinement process. The environment may be significantly harmed by such activities, necessitating quick remediation and the adoption of suitable preventative measures. Here are just a few examples of the myriad ways that oil refineries harm the environment.

On-site Activities That Pollute the Water

Crude oil is processed in an oil refinery to create petroleum products like gasoline, diesel, and heating oils. Potential petroleum product leaks at different stages of the petroleum refinement process contaminate the soil and groundwater. Such activities could cause significant environmental harm, necessitating prompt remediation and the adoption of suitable preventative measures. The numerous ways oil refineries harm the environment are just a few of them, as shown in the following examples.

Hydrocarbon Movement on the Ground Surface

Spilled or leaking substances are drawn downward by gravity, where they may be absorbed before they reach the water table. Faster than water, lighter oils penetrate the soil more readily than heavier ones. The water table can be contaminated by an oil spill even if it is far from it. The pollution may be concentrated on the water's surface by precipitation or may be carried to the water table by heavy rains that raise the water table. Because they are lighter than water, hydrocarbons at the water's surface will change in concentration as the water table does. The solubility of the product's components also affects how severe the pollution is because lighter fractions have more soluble components than heavier fractions.

Hydrological Characteristics of Soil Formation

Spilled or leaking substances are drawn downward by gravity, where they may be absorbed before they reach the water table. Faster than water, lighter oils penetrate the soil more readily than heavier ones. The water table can be contaminated by an oil spill even if it is far from it. The pollution may be concentrated on the water's surface by precipitation or may be carried to the water table by heavy rains that raise the water table. Because they are lighter than water, hydrocarbons at the water's surface will change in concentration as the water table does. The solubility of the product's components also affects how severe the pollution is because lighter fractions have more soluble components than heavier fractions.

Effects of Human Interference on Groundwater Movement

Land management is the primary factor in determining whether to stop or permit ground water to flow into the underlying aquifers. On industrial sites, large-scale terrain modification happens for a variety of reasons related to industry needs. With such a change in land use and cover, followed by high levels of human activity, ground water flow is stopped and the chance for ground water recharge is diminished. Refineries cause land disturbance, so spilled material finds its own path and is more likely to spread contaminants to nearby areas[21]. Building construction, sealing of the ground surface, installing underground services, and the impact of pumping from building sumps are some of the factors that influence the terrain characteristics. The refinery area's hydrological and hydrogeological conditions determine the contamination hotspots. Consequently.

Area of Storage

In addition to large tanks at "tank farms," smaller drums, and bulk storage, there are storage options for feedstocks and finished goods (typically additives and finished products only). Tank farms frequently have a large number of tanks inside of product- contained bunds. Bunds should also be used in these locations where drums are frequently stored, even if only temporarily. The likelihood of contamination in the chosen area is influenced by the storage tank's quality, the bund's structural soundness, and its age.

Product Transfer and Loading and Unloading

The majority of refineries are situated on or near the coast, and feedstocks are frequently moved by pipeline or ship. When products are moved, there is a noticeable possibility of spills and leaks. Oil interceptors may not have always been present in these areas, and tank flushing may have previously occurred uncontrollably[22]. The main source of leakage is the making and breaking of connections, even though loading gantries for rail and road may be present (even though pipelines are now used for the majority of product transport). Spills would have quickly soaked into the ground because rail loading gantries are typically constructed on highly permeable ballast. These areas should receive adequate attention, especially on older sites where redevelopment could obscure earlier practices.

Waste Disposal Areas

Process waste (oily sludge from tanks and wastewater treatment, used catalysts, furnace linings, and ash), acid tar, construction waste, scrap metal, and office, canteen, and clinical waste are just a few of the sources of on-site solid waste[23].

Demolition of Rubble and Asbestos

When older refinery structures are demolished, the surrounding soils may become contaminated with asbestos, particularly if the material is recycled on-site. However, any structure built before the late 1980s might have contained asbestos. The primary sources are boiler houses and structures with plumbing and boilers. As a result, asbestos may be found everywhere on the property, though old boiler sites are the most likely places to do so.

1.3 MOTIVATION

After studying and considering the aforementioned issues, it has been found that the globe is very closed to available limit of potable water supply because population growth and economic pressure. Groundwater pollution is a result of untreated sewage, mobile community sanitation systems, farm runoff, and industrial waste. About 25% of the people in India live along the length of the nation's coastline. Coastal aquifers are among the most productive, but saltwater intrusion contaminates them. Most oil refineries are located near the coast[24]. An oil refinery is a type of processing plant used to turn crude oil into petroleum products like gasoline, diesel, and heating oils. Potential petroleum product leakage in underground pipes and surface tanks during different steps of petroleum elaboration in oil refineries frequently contaminate soil and groundwater. The industrial and coastal nature of the region led to saline water intrusion, numerous process operations, and the contamination and depletion of potable ground water aquifers. Such activities might have a very bad effect on the environment, calling for quick remediation and the adoption of appropriate preventative measures.

1.4 GROUND WATER MODEL

In order to estimate habit recovery and to check ground water right, we often use the ground water model. Depending on the goals the researchers were trying to achieve the goals, they put the different assumptions for the different modeling purpose. For the habited recovery, they were assuming conservative measurement of the flow recover because of the unavailability of estimation of predicted mean habitations. Area marked in the modelling for the survival of given habited were projected and they are actually not available and also may not be adequate time to given remedy conditions. When the water rights established during modeling which may conversely, under marked of depletion cause legal harms because users may be imposed by senior users imposing rights. Because of above inequality, it is necessary to create purpose of model before it is implemented for any type of the work.

Ground water is the one of the sources of the water in the India for drinking purpose. Most of the population in the India are reliable on the ground water as the portable water. Water irrigation services are there in the city region may not available in the rural area but they are mostly using the tube well as the one of the sources of the water for the drinking purpose. Free charge and fresh source of water body is help in the maintaining good human health, surface water is only the source of good quality water for drinking purpose. Good water quality water and safety water is only the ground water and the surface water may be contaminated with the minerals and other impurities which is dangerous for the health which create problem such as hair loss, diarrhea, nail loss, disorder figures, mottle teeth, lungs irrigation, liver damage, cardiovascular disorder, nervous system damage, neurological problems, paralysis and cancer etc. Rain water falling in the river is the important source of the ground water and gets after that it gets mixed with industrial waste and ration of dissolved oxygen to ion is there hypothetical. These types of contaminated water may create serious difficulties for the humane being as well as primary bodies for the water. Peoples in the developing country are very aware about this type of contaminated waters in terms of economic and technological problems.

Life is so important and therefore, one cannot compromise with the quality of water so far. Everything was happening in the water and water are very useful to keep atmosphere temperature below certain limits by preservation. All living and aquatic life gets diminishes without water. Water requirement is very important in the industrial development as well as hydroelectric power generator, industrial procedure and for the wild life etc. therefore, water is the very important component in the monitoring the life cycle and climate condition[25]. Climate is the physical armed forced and it is mostly associated with the environment. Man relive on the water need is the portable water. Earth depends mainly on the rain water to protect the clean water on the surface but sometimes randomLy in the rain fall may cause drought or disaster flood. Clean water is the primarily requirement of the human being but in order to get this rain water in clean and portable way is very challenging task as the rain water is contaminated with many minerals and other industrial waste.

1.5 SOURCES OF FRESH WATER

Small part of country generally possesses good source of the water in comparison to rest of the large part of the country where scarcity of water resources is there. Number of water bodies are there in the form of the tube well. Water shortage area were crops development causing problem for the growth enlargement because of the insufficient amount of water supply. Its therefore very important that the equal water distribution in the earth surface and main water sources are as follow[26].

1. River water
2. Rain water
3. Ground and surface water

Rain water is available only in the monsoon season there after its gets missing for the certain months so only few months source of water is rain water during rainy season. Ponds and Lakes containing rain water is also gets fall in to the continuous in the rivers and little rain water may gets hold by the surface in the form of surface water. Lake containing rain water is very useful for the long period of time. In India, number of natural lakes are there but it is not sufficient to hold the rain water and therefore it also required to constructed artificial lakes[27]. Rivers are the big sources of the water few rivers are charged by rain water and few rivers are charged by melting of snow from the mountain hilly region[28]. Surface water is defined as the water hold by the soil inside it. At preset we are using more than 25 percentage of the surface water. This water body is useful for the agriculture. Requirement of this type of sources is reduced because of the it's excess use and also agriculture are is reduced because of the population. Total surface area of earth is occupied with 71 percentage sea water and remaining parts were fresh water and life is there. Water sources are mainly divided in to two categories such as salty water and fresh water. According to NATA, 2006, the fresh water is the water which having salt concentration is less than 0.5ppm. Physicochemical parameters of the fresh water may get affected and alter because of the mineral's contaminations, sewage mixing agriculture and industrial waste contamination etc.[29].

Surface water is the one of the important storages of water in the India. India in the rural and urban parts are mainly reliable on the surface portable water. Portable water body is the tube well which is free from the pollution and clean water bearing source[30]. Fresh and clean water is very primary requirement of the human being for sustaining their health. Surface water is only the tremendous source of the portable water by now a day surface water gets contaminated by melting of minerals and solvents as well as heavy trace metals which contaminated water and may seriously causing problems such as hair loss, diarrhea, nail loss, disorder figures, mottle teeth, lungs irrigation, liver damage, cardiovascular disorder, nervous system damage, neurological problems, paralysis and cancer etc. [31]. The level of nitrate was checked in the region were sample collected in the monsoon and was found to be decreases in the season winter and summer than the desirable limits for the remote area were water used for the drinking purpose. Total dissolved solid is also more than the desirable expected limit which may also create problem like kidney stone. Reason for these is that the salinity of water may causses several alterations and also change the several parameters of the water. In 1972, peoples have worked to store the fresh water requirement and in 1996 amongst the 16204 countries the total number of schemes for fresh water was established are less than 200. 1974 system was included harmLess portable water state wise. Now in presence ecofriendly agency controls water chemical contaminations and government has concern more on important of humane life's value and make the policy for the fresh water rights for peoples.

Why freshwater requirement is the emerging challenge:

1. Present treatment may not sufficient

2. Shifting geographically and increasing in the population

3. Progress gets weakened and speculation in the study.

Water is the very useful for the animals, human and plants. Water is area based depending on the micro vegetation and micro wild life. Generating settings for the dangerous significant. Drinking water is the one of the most evolving as one which cause sparing of life spam. The social body bearing 70 percentage waters. Prediction data said the in the year 2030 were more than 45 countries facing the scarcity of portable water and its big challenge for getting fresh water. At presence Ethiopia, Kenya, India, Nigeria and other four countries are facing scarcity of in coming next 15 years. Few large populated countries like China facing scarcity of water at present due to population. It is necessary to think on this direction to avoid such problem in the future so its required to arrange necessary water storage body sources.

Because of the improper water administration, dangerous waste may fall in to water, improper waste disposal, industrial influents disposal etc. which may create people's hygiene problem in every part of the world. Number of peoples are loss their life because of water born diseases commonly called cholera, typhoid and schistosomiasis harm. Wastage and contaminated water supply is also very serious issue for the atmosphere and environment conservation is concern. Fresh and clean water is the expectation of every people in the earth for their survival.

Water falling globally is very important for the population growth, environment protection, urbanization developments, aquatic life sustainable etc. most of the nations are aware regarding the requirement of fresh and clean water and they all are comes forward and making steps toward fresh and clean water policy. In the international agenda, fresh water availability is the highest priority for the country. Fresh water requirement for the mankind is the big challenge as it has been supplying near to extinct or almost getting over.

In most of the nations, now a day ponds and river are the sources for the dumping of industrial waste, untreated poisonous dumped and hazardous chemicals that spread on the surface of the earth. Community residing in the said area are depends on the ground water availability which may create problems as the increasing in the population and day by day peoples need is also increases. Increasing in the population in the any developed country may facing problems now a day for the availability of water.

The shortage of availability of fresh and clean water is the problems of most of the nations in terms of humane life and growth of population vegetations. Impure and contaminated water are the serious and big problem for the peoples who are residing in the country in the world. Poisonous water, aquatic scarcity over 12 million population in every year may have dangerous issue regarding health problems and over many states have create law regarding policy for the not polluting water or to preserve the fresh water without any kind of contaminations. Progress in the transparent way at internationally, most of the country have made policy and plan for the fresh water requirement for the future generations.

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CHAPTER – II

REVIEW OF LITERATURE

CONTENTS

Rapid urbanization, economic activity, and population growth have led to excessive groundwater extraction, resulting in a decline in groundwater level and a lack of water supply for future use. Despite India's abundant rainfall, runoff is rising in urban areas due to the construction of paved surfaces and storm water drains[32]. As a result, large towns, especially those which are situated on water divides, are experiencing saltwater intrusion beneath them, land subsidence, wells drying up, damaging ecosystems, and groundwater depletion. The best method for reducing surface runoff and recharging groundwater artificially is rainwater harvesting. In India's densely populated coastal regions, ground water is a huge resource of water for various application. It is now widely accepted that ground water quality is just as important as quantity in major cities and towns around the world due to the depletion and scarcity of ground water. Without reviewing prior work, innovations and ideas cannot be put into practice. The literature review that is presented here is divided into four sections[33].

1. Harvesting rainwater.
2. An improvement in water quality following rainwater harvesting.
3. An increase in water availability following rainwater harvesting.
4. Recharge of ground water using GIS and modelling methods.

2.1 HARVESTING RAIN WATER

Since rainwater harvesting is a tried-and-true alternative that is crucial to the local and regional hydrological cycle, many nations use it as a workable decentralized water supply. Direct infiltration, rainwater storage in ponds or reservoirs, and bore hole recharging of groundwater aquifers are other alternatives to individual rainwater harvesting systems in densely populated cities and coastal regions. To better understand the idea behind rainwater harvesting, the following academic works are examined[34]. In India's water-scarce regions, listed six significant difficulties in rainwater harvesting. Low local supply capacity as a result of high demand and unreliable supply, i.e. (ii) The cost-benefit analysis of rainwater harvesting lacks empirical support. (iii) Because of a good "trade-off," improved hydrological benefits, and financial efficiency. (iv) Maximizing the advantages of upstream water reaping and exploiting basin-wide advantages. (v) Water supplementation has less hydrological advantages than local water recycling. (vi) In hard rock environments, the capacity for artificial recharge is decreased by a lack of integration between ground water and surface water systems.

In addition to the laws and regulations, barriers, incentives, and other voluntary and regulatory systems, explained the policies and programmes for rainwater harvesting at the municipal, state, and national levels in the United States[35]. He also discussed how managing stormwater can help prevent combined sewer overflows, the benefits of collecting rainwater as a way to supplement water sources, and how to manage irrigation systems how to cut back on energy use, greenhouse gas emissions, and water withdrawals, among other things. The author provided a summary of the available research, current trends, potential advancements, and snow melt[36].

Julius et al[37]examined rainwater harvesting systems in India and around the world, including their processes, designs, implementation, and impacts. explained the policies and programmes. According to the author, the demand for clean drinking water increases along with the growth of the global population. Surface and groundwater bodies are detoriated very fast then they are reconstruction. The best solution is effective water resource management and education about how to use water resources most effectively, including proper water harvesting, recharging, and improving the water quality of water bodies.

Dakua et al[38]. calculated the power of rain water harvesting in small and large building in Dhaka as well as the economical advantages of rainwater harvesting, explained the policies and programmes. The paradig in Bangladesh was bringing the possibility of a permanent water shortage in the city of Dhaka's water supply scenario closer to reality. The surface water levels of Dhaka's peripheral rivers also prevented increased use of surface water because the subversive aquifers drop underneath the driving near or dry up. Given Bangladesh's heavy annual rainfall, the nation's entire demand for water could be satisfied by rainwater[39]. The users were unaware of its potential power.

Lokeshand and Rao[40] Conducted a study in parts of Chittoor district, Andhra Pradesh, to identify water harvesting structures described the policies and programmes (WHS). In order to raise and recharge ground water levels in Karvetinagaram Mandal, this research includes gathering rainfall data, cropping and irrigation information, identifying current water reaping constructions (WHS), and offering new WHS, among other things. The cost estimate for the twenty-four harvesting structures (WHS) is 56 lakhs. The storing size of the present and forthcoming WHS is 174.52 ha. With a capacity of 122.4 ham, percolation tanks (PT) have the highest capacity, followed by check walls (19.0 ham), check dams (16.2), mini-percolation tanks (MPT) (11.8 ham), and staggered percolation tanks (SPT).

Netzer and Yakov[41] evaluated the history of rainwater collection and looked at how it affected the hydrological system in contemporary urban settings. There is discussion and comparison of various methods for collecting rainwater, including storing collected water in reservoirs and injecting collected water directly into aquifers. According to measurable samples from Tel-Aviv, Israel, rainwater group could play important role in the resident and area hydrological cycle and direct infiltration of gathered water into the aquifer is preferred for densely populated areas. To determine whether collecting and using rainwater is a financially viable, regional strategy[42] looked at the benefits and drawbacks of rainwater harvesting. The land use, terrain, and rainfall variability of the watersheds are used to assess different cistern sizes. Depending on the size of the cistern, the annual water recovered might be sufficient to satisfy the requirements of 13,345 to 31,138 single-family homelands. If water prices stay the same, only the smallest irrigation cistern is economically feasible. It has been established that rainwater collection for outdoor use saves the most water, power, and carbon by calculating the amounts of water, electricity, and carbon saved in two situations: outside only, and outside + non- drinking indoor application[43]. During a periodof 2–100 years, the RWH scheme decreases excess volume greatness by 145.95 to 333.06 through 24-hour rainfall, giving to the information. However, this quantity of decrease effect strength satisfy domestic ingesting needs ranging 202.50 to 462.11%, with an financial impact of 10,008.98 to 22,840.65. (USD).

Sepehri et al[44] hence investigated that how rainwater harvesting affected runoff volume and household water use. Using a well-known and effective flood hazard strategy, such as the SCS, the flood volume was calculated in the HEC-HMS model with various return durations. The biggest environmental risk in Hamadan is flooding. The data showed that over a period of 2 to 100 years, the RWH system reduced runoff volume magnitude with 24-hour precipitation by 145.95 to 333.06 percent. However, with an economic impact of between 10,008.98 and 22,840.65, this amount of the reduction effect might be enough to cover the 202.50 to 462.11% range of household consumption needs (USD). 5In most areas of the education area, precipitation gathering from roofs, space lots, and infrastructures could be vital in dropping the risk of submerging and provision everyday needs in the nonappearance of urban manure systems[45].

2.2 IMPROVEMENT IN QUALITY OF WATER AFTER RAIN WATER HARVESTING

Human activities affect the ecosystem, which is a undesirable effect on the quality of ground water. In industrial and coastal areas, intrusion of salt water is a major cause of contamination of potable ground water aquifers. Because groundwater has so many uses, the impact of contaminants on its quality in coastal areas is a crucial issue. The impact of rainwater reaping on crushed water quality in seaside and additional areas has been deliberated by the authors. Here is the main idea.

In Tarapur, Maharashtra MIDC[46] investigated the risk of pollution in an industrial area. The area is located along the Arabian Sea coast of India. The 131 samples for ground water chemical analysis were collected from borewells, dug wells, irrigation channels, effluent sumps, creeks, and the ocean. The analysis indicated that the region has hard water and a high salinity hazard. Other industrial areas along the Indian Ocean coast may also benefit from taking the corrective measures suggested by the study. It has been suggested to regulate and manage industrial emissions near Tarapur MIDC.

In two different areas of Chennai, Tamil Nadu, India, with various hydro-geological conditions for the quality and quantity of water[47] constructed rainwater harvesting systems. Site factors like hydrometeorology, lithology, and land use have an impact on the rainwater harvesting structures. The effect of rainwater harvesting for potential recharge is measured using the GEC standards 1997 water level fluctuation process. Several sample water were analyzed for quality checked parameter in accordance with IS-10500 1991. Water has increased the recharge and quality, as per the results of the implementation and analysis. This report is a follow up to a prior study that looked at roof harvested rainfall[48]. Through the use of rainwater harvesting[49] established useful and financially viable water supply alternatives for underdeveloped regions. By tracking the concentration of the selected pollutants over an extended period of storage, the study tracks compliance with drinking water standards over time. A recommendation for rainwater storage is being made. For small-scale, domestic applications[50] established practical and economically Observed the quality of rainwater harvested for roofs. Determining whether there is important difference in pollutant attentiveness and water features over extended aeras of packing was one of the goals, as was calculation out the belongings of any variations in water features (quality) in the growth of top water attention and storing knowledges. Results for seven parameters, including pH, turbidity, phosphorus, zinc, copper, ferrous iron, total iron, nickel, and nitrate, are presented in this study. The study's findings can then be used to create suggestions for rainwater collection and storage as well as the layout of a system for collecting and storing rainwater[51].

To study the effect of rain water harvesting on the quality of ground water[52] constructed the rainwater harvesting structures at the Jamia Millie Islamia university campus in New Delhi, India. At many JMI locations, rainwater harvesting systems with a 20 m depth have been installed. Understanding more about the analysis, these data were processed and compared, and the results show a very intriguing figure in terms of ground water quality change, supporting the claim of quality improvement. Ground water samples were collected and analyzed throughout the months of February 2011, November 2011, and April 2012[53]. The study's findings and interpretations indicate that recharging with rainwater improves groundwater quality, but this depends on the amount of rainfall and the environmental factors that allow for rainwater collection and recharging.

Rainwater collected from galvanized roofing sheets of various ages was examined[54]. For three years straight, samples of rainwater were collected on a monthly basis. The samples were taken between July and September from roofs that ranged in age from 5, 10, and 15 years, and they were then examined using standard techniques for physical, chemical, and microbial parameters. The outcomes were then contrasted with three current drinking water standards: NSDWQ, 2007, WHO, 2011, and USEPA, 2012. The samples' pH ranged from 6.5 to 8.5, which is regarded as normal. The regulatory limit of 150 mg/L is well below the hardness measurement of 41.96 mg/L. The lead content is within the permitted range of 0.01 to 0.015 mg/L, ranging from 0.0033 to 0.0055 mg/L. The faecal coliform Escherichia coli level of 0 cu/mL is acceptable and does not suggest biological contamination. The harvested rainwater from GRS of various ages in Ogbomosho, Southwest Nigeria, does not exhibit any appreciable variation in the quality of the water or any adverse effects on health.

On a qualitative level[55] investigated the state of the groundwater in the Indian city of Bilaspur. Six strategic sampling stations were gathered over a six-month period in 2013[56], from March to August. As the seven main parameters for the study, pH, chlorides, sulphates, conductivity, TDS, nitrates, and fluorides were selected. The groundwater quality review's findings were appalling and fell far short of the standards set by various international organizations. The local government, community, and NGOs were urged to take prompt preventative action. To prevent sewage and industrial discharges from contaminating groundwater supplies, the authority should promote rainwater harvesting and natural precipitation recharging of groundwater.

In Aligarh[57] assessed the impact of mining activities on ground water quality, and Khawajam Anwar and Vanita Aggarwal (2014)[58] examined the water quality of underground water for the year 2012 using 14 parameters. Various samples from various locations were gathered for the analysis. For the pre-monsoon and post-monsoon periods, the ground water quality status was evaluated using the Water Quality Index method. The water quality index, a useful tool for identifying the spatial and temporal variations in ground water quality, was used. In contrast to Goa, where water quality was observed to be in the very good category, ground water in Aligarh required some treatment before it could be consumed.

In order to increase groundwater level/storage and improve water quality by artificial recharge[59] concentrate on the detrimental effects of excessive groundwater diversion and rainwater harvesting potentials in Dhaka city. 85–90% of the city's water comes from groundwater, with the final 10-15% coming from filtered surface water. Groundwater levels were dropping at a rate of 2.5 meters annually as a result of over-abstraction**.** Additionally, the hydrogeology of the area is changing as a result of excessive groundwater abstraction. The main aquifer (Dupe Tile) has become unconfined in nature beneath the majority of the area because its uppermost portion is nearly dry. A substantial depression cone has grown. In order to address the problems with the sustainability of the groundwater supply and the vulnerability to contamination, immediate action is needed. Water quality is also being degraded by seepages from urban and industrial wastes[60].

2.3 IMPROVEMENT IN QUANTITY OF WATER AFTER RAIN WATER HARVESTING

Artificial groundwater recharge's main objective is to replenish aquifer sources that have been exhausted as a result of excessive groundwater extraction. The systematic application of data collection techniques, as well as data analysis and interpretation, are required for the study of ground water recharge[61]. In order to recharge groundwater aquifers with rainwater, a bore hole must be dug specifically for the purpose of rainwater harvesting. The following is a list of books that have addressed ground water recharge.

Explained[62] that improving ground water conditions like hydrodynamics and physiochemistry can be accomplished through artificial recharge from dams for water table aquifers. Additionally, it was stated that calculating soil infiltration rates is essential for maintaining sufficient permeability and the absence of polluted areas. Tunnels, shafts, and wells injected into aquifers may be used directly if the soil does not have permeability. The location of an unsaturated zone between the land surface and the aquifer must be known. The current unsaturated ozone layer aids in the proper design of a groundwater system for artificial recharge as well as the creation of basins, furrows, ditches, or other facilities for surface water infiltration into the soil.

When the reservoir filled with floodwater[63] used processing mode flow software to create a groundwater model to show how the area naturally recharged. Jordan's Wadi Bayer is a dry desert area with scant rainfall and poor water supplies. The groundwater table will rise by 0.33 to 1.5 m and 0.11 to 0.90 m, respectively, for both retention times. The surface runoff was determined using a home-made spread sheet model and a HEC-HMS model. It is a prime illustration of Jordan's historic water shortage. Due to harsh climatic conditions and high evaporation rates, ground water recharge is one of the long-term solutions to such water shortage situations. The Riham formation and alluvium deposits are the only rock unit groupings found in the study area. The permeability of the reservoir floor is 11.82x10-2 cm/sec. Seven boreholes were dug at the location, with depths ranging from 5 to 15 meters. Permeability tests were carried out at various depths, with results for 30- and 15-day retention cycles ranging from 7.331x10-6 to 1.805x10-3, respectively.

For the purpose of preserving soil moisture[64] created the sand ditch, a novel water harvesting technique. Water harvesting is a practical solution for agricultural production in semi-arid regions. The sand-ditch technique, which helps to reduce sediment losses and runoff while increasing soil moisture and infiltration, was tested in the field as opposed to managed or compacted plots. On a field measuring 10 m by 2 m, twelve plots with various soil depths and silt loam soils were constructed. Average runoff was 46% lower and sediment losses were 61% higher in the sand-ditch plots compared to control plots, with sediment losses 2.2 and 6 folds. It has been determined that, given the current climate, soil compaction was an ineffective method for collecting rainwater.

In their 2012 study[65] concentrated on the restoration of ground water through the use of rainwater recharge. For the factors governing the ground water discharge and recharge in the area, the necessity of implementation and potential for ground water recharge were analyzed. Aquifer geometry and characteristics, ground water requirement, ground water level behavior, ground water quality, rainwater quality, rainfall intensity and distribution, ground water and rainwater potential. The quantitative potential of ground water was determined through mathematical calculations. Techniques for artificially replenishing ground water in the Dwarka sub-city would help to alleviate water shortages in the city and other urban areas. The relevant water supply agency is only providing Rs 2.8 MGD despite a demand of 10 MGD from a population of about 5 lakh. As a result, groundwater provides the majority of the residents' needs for both domestic and non-domestic uses of water. The depletion of the fresh water layer, a decline in the water table, and a water shortage have been brought on by the extraction of ground water by both public and private entities.

With the aid of a hydrogeological[66] focused on groundwater vulnerability analysis and created hydrogeological modelling (GIS). Water causes flooding and commotion in the community, which is a challenging problem for the environment. For the quantitative capacity of ground water, the technology of ground water recharge by rainwater collection was advocated. The land of Jamia Millie Islamia has been divided into ten zones for the installation of rainwater collection structures. The amount of ground water is replenished and increased by rainwater, which is also influenced by the climate where it is collected and the amount of rain.

By analyzing the time distributions and spatial variability of rainfall[67] were able to determine the intensities of rainfall and events of duration pattern of rainfall. Increased flooding results from the shortening of the rainy season and an increase in rainfall events' intensity. According to observations, more water will be directed into streams and rivers, causing a loss of water resources in the local environment, if the trend is allowed to continue and appropriate action is not taken. To cope with the frequent flooding, adaptation strategies to climate change are being developed. Hourly rainfall data can be improved by using hydrological models of water balance analyses and characterization of flow mechanisms instead of daily rainfall data.

Infiltration rates in the Florida basin were examined[68], who discovered that they significantly deviated from the intended infiltration rates (DRI). Forty infiltration basins in Florida were examined for this. Sand, loamy sand, sandy loam, and sandy clay loam were among the different soil textures that were clearly distinguished in the basin's soil. Based on the DRI rates, there were fourteen basins (or 35%) with infiltration rates higher than their designed rates, sixteen basins (or 40%) with infiltration rates lower than their designed rates, and ten basins (or 25%) with infiltration rates equal to their designed rates. DRI rates for soils with greater coarseness exceeded design rates.

According to[69], a number of factors, such as seawater intrusion, dissolution, reverse ion exchange, water rock interaction, and agricultural impact, have an impact on the hydrochemistry of the coastal aquifer. In the post-monsoon season, ground water samples from 48 locations were taken from bore wells using standard methods for major ions and in-situ parameters. The methods used to analyses the water quality indices included ionic ratios, geochemical plots, geochemical modelling, and statistics. The EC was 7155 S/cm, and the pH ranged from 6.6 to 8.0. The saturation of Calcite during its evolution using hydrochemicals was primarily caused by the availability of Ca and HCO_3 ions using a saturation index. The water in the study area was suitable for agricultural use but not for drinking.

By maximizing the use of water resources[70] constructed a RWH system for a South Indian University (SIU) in order to transform the current campus into a green endeavor. The quantitative and qualitative facets of rooftop storm water discharge were examined in an integrated study. The SIU can assist in reducing water scarcity during the non-monsoon season by storing stormwater from rooftops, which totals 1,13,678.9 m^3 annually. These conclusions may have a significant impact on other public and private organizations as well as RTRWH programmes for long-term water management.

2.4 GROUNDWATER RECHARGE USING GEOGRAPHIC INFORMATION SYSTEM (GIS), REMOTE SENSING, AND MODELING METHODS

By combining traditional hydrogeological survey data with geographic information systems, it is possible to identify areas that are suitable for rooftop rainwater harvesting using GIS (geographical information system) and remote sensing. Different modelling techniques can be used to identify and analyse groundwater recharge zones and capacity. A methodology for sustainable water management was developed by several authors[71].

By combining remote sensing and geographic information systems[72] pinpointed the area for groundwater recharge and outflow in catchments that are susceptible to salinity. This method is being used in a dry area of southern Australia with a salinity-prone unconfined basalt aquifer. The basalt aquifer spans 11,500 km2 within an area with a high concentration of farms. The past has made extensive use of bore data to identify the recharge and discharge zones (especially potentiometric surfaces and depth to groundwater data).

Thornthwaite and Mather (TM) model for rainwater harvesting was used[73] in the development of a water balance model at Jammu Himalaya using remote sensing and GIS techniques. The analysis is very helpful in identifying a watershed's moisture surplus and deficit. Only 11% of the Devak-Rui watershed site was suitable for rainwater harvesting out of the total runoff of 1,429.26mm, with the remaining 89% being unsuitable.

At the University[74] created SLUGGER-DQL, a piece of software that works with remote sensing and geographic information systems to help identify potential rooftop rainwater harvesting and artificial recharge sites. The use of conventional hydrogeological survey data allows for the determination of which locations are suitable for rooftop rainwater harvesting.

A conceptual framework for the long-term management of drinking water was provided[75] by assessing the current condition of the water supply system in Allahabad. We developed solutions for the current water supply problems by identifying various challenges and holes in the current system using a GIS framework. Various types of pertinent data have been stored in ArcInfo for use in other applications, analysis, and decision-making. In Allahabad, the rainfall recharge was calculated (Arc Info). Using data from 1997 to 2007, a comparative analysis of various hydrological parameters for pre-monsoon and post-monsoon ground water level, as well as water table variation, was carried out to better understand the changes that have occurred over the past ten years. In order to evaluate ground water recharge potential areas, the recharge regulating parameters were assessed and various groups of thematic maps were created. Each parameter has a unique impact and contribution when it comes to evaluation[76].

To estimate groundwater heads and the extent of intrusion from 2011 to 2020, Sindhu et al[77] developed a numerical model for groundwater flow and pollutant transport using Visual MODFLOW and SEAWAT. Predicted ground water heads in the vast majority of monitoring wells are decreasing. The coastal aquifers in Trivandrum are susceptible to saltwater intrusion due to the downward trend in groundwater heads that creates a gradient towards the land.

According to Lin et al.[78], the agricultural, aquaculture, manufacturing, and domestic sectors have placed enormous demands on water, leading to over pumping and, in some cases, steadily declining groundwater levels. Land subsidence and soil salinization have resulted as a result. Consideration should be given to regional pumping operations or costs in order to enforce effective water management. SWAT and MODFLOW are used and were run independently to accomplish this. SWAT simulated recharge rates and the spatial distribution of unconfined aquifer hydrological characteristics are used to establish the potential recharge zones. After that, the water balance method (WBM) was used to measure pumping rates for these components. The results of WBM and the official documents were compared to validate the proposed model. The artificial recharge is seen as an important method for alleviating and mitigating the subsidence. The proposed technique has been proved to be efficient by suggesting preferred recharge zones. A GIS-based framework for hydrologic modelling was proposed[79]. Using AGWA, the soil and water assessment tool's parameters were set (SWAT).

Simulations showed that changes in land use have increased surface runoff and decreased groundwater recharge. Observational data from the 1990s with high annual concordance were used to calibrate the SWAT model. Changes in land use and land cover in Kenya's Rift Valley have affected the hydrologic response of the River Njoro watershed by changing how extra rainfall is divided between surface discharge and groundwater recharge. An analysis of the hydrologic response to changes in land cover using a hydrologic model. Will give insight about land use and groundwater recharge relations The watershed also provides a significant amount of water to the surrounding communities and the city of Nakuru.

Using GIS and remote sensing methods[80] potential groundwater recharge sites were identified at India's Hirakud Canal. Due to poor and unscientific water management practises, extensive deforestation, and irrational irrigation water use, the western part of Odisha experiences a drinking water crisis almost every year. The GWPZI (groundwater potential zone index) map, which is influenced by numerous factors including land use, land cover, soil type, and geology, is being developed using the Analytic Hierarchy Process (AHP). Three zones have been established for the Hirakud command region: bad (18.79%), medium (45.59%), and strong (35.61%).

Zhang et al.[81] reported the use of SWAT (Soil and Water Assessment Tool) to evaluate how management practices and climate change affect the availability and quality of water. The uncertainty analysis and calibration tool SWAT (CUT-SWAT) was employed based on the cloud. This is a challenging study because it requires a lot of model runs. Depending on the complexity of the model, the SWAT (CUT-SWAT) model accelerated uncertainty analysis and calibration processes by 21.7–26.6 times. Models are a perfect solution for addressing issues with computational demand in hydrological modelling because they can provide a fault- tolerant and adaptable environment.

Shashikumar et al.[82] developed a modal using GIS and visual MODELOW for growing flow in a hand work a qui for in the Kodaganar watershed. Groundwater recharge potential areas were found using the weighted index overlay method of GIS. For various thematic maps, soil type, geology, land use pattern, geomorphology, and slope were among the factors taken into consideration. Three categories were used to categories the groundwater recharge potential zone: strong (23%), moderate (54%) and bad (23%). There were good and moderate potential zones as well as bad zones because the pediment inselberg and charnockite hardness were present in the area. Because of this, more artificial recharge structures can be placed in the watershed's centre.

A numerical model for the sustainability of the groundwater aquifer system in Zhanjiang was presented by Zhou et al.[83]. The groundwater budget indicated that the coastal groundwater was overexploited (-3826 x 104 to -4502 x 104 m3/a). The simulation results predicted that under the current groundwater extraction schemes and mean sea level rise, the risk of sea water intrusion would rise in the future, especially for unconfined groundwater in coastal areas and Nansan Island.

Ibrahim et al.[84] Using ArcMap 10.4.1, I built a model builder and selected potential dam locations. The model made use of land use/cover, slope, runoff capacity, stream order, soil quality, and hydrology. Using Landsat image data from 2018, land use and land cover classes were determined. The slope mapping and drainage order were extracted using a digital elevation model, and supervised classification was carried out using ENVI 5 software. Interpolating the rainfall data spatially was done using inverse distance weighting (IDW). The results showed that the central and northern regions of the study areas, as well as heavily cultivated zones, are the best places to collect water. The most prevalent soil type in these suitable sites was loam, with rainfall ranging from 750 to 900 mm. The findings showed that 15% and 13%, respectively, of the study area are suitable for water harvesting in excellent and good ways. In addition, 21% and 27%, respectively, of the examined region were found to be moderately and poorly appropriate, with the remaining 24% being unsuitable.

2.5 GEOGRAPHIC INFORMATION SYSTEM

Numerous researchers have discussed the various uses, advantages, and disadvantages of rainwater harvesting systems, as well as the difficulties they encounter. The strategies, systems, practices, architecture, and implementation of rainwater harvesting were also clarified. Review the history of RWH, cost-benefit calculations, and the impact on the hydrological cycle. It has been made several researchers established the potential of rain water harvesting mechanisms for small and large buildings, as well as the potential of RWH systems, using modelling techniques like HEC-HMS, GIS, and others. The amount of recharged precipitation as well as the environment for collecting and recharging rainwater are key factors in raising the quality and quantity of groundwater. The danger of pollution in an industrial area was investigated, with a focus on the detrimental effects of excessive groundwater diversion. The quality of rainwater collected from roofs for small-scale, domestic applications. observed and examined Among other parameters, pH, conductivity, TDS, chlorides, sulphates, nitrates, and fluorides were chosen as ground water quality indicate and for diagnostic purposes. The ground water quality status was determined using the water quality index approach, which is a great tool for analyzing temporal and spatial changes in ground water quality.

The researchers described how site conditions like hydrometeorology, lithology, and land use have an impact on the construction of rainwater harvesting structures. The researchers calculated rainfall recharge using the rainfall infiltration factor method and the water table fluctuation method after comparing a number of hydrological parameters (pre-monsoon ground water level, post-monsoon ground water level, and water table fluctuation)[85]. Many researchers developed various techniques, like sand ditches for soil conservation and moisture retention. Additionally, the hydrochemistry of the coastal aquifer was examined, along with the infiltration rates of the basin, and the HEC-HMS model was developed to calculate surface runoff. According to the literature review, it is demonstrated that artificial recharge is a workable solution for improving ground water conditions like physiochemistry and hydrodynamics[86].

Several researchers have identified potential areas for groundwater recharge using GIS and remote sensing. Geographic information system (GIS) databases are used to benefit hydrogeological modelling and groundwater vulnerability analysis[87]. This analysis and decision-making programme can help with long-term water conservation. Several models, including a water balance model for rainwater harvesting based on Thornthwaite and the Mather (TM) Model, have been developed. A programme called SLUGGER-DQL can be used to locate potential rooftop sites for artificial recharge and rainwater harvesting[88]. To create a numerical model for groundwater flow and contaminant transport as well as to forecast groundwater heads and intrusion extent, visual MODFLOW and SEAWAT were used. Using hydrologic models like the Soil and Water Assessment Tool, researchers examined how management practices and climate change affected the quantity and availability of water (SWAT). Small spaces and places with limited access to information can also be used to simulate SWAT operations[89].

A thorough review of the literature revealed that while most researchers agreed that rainwater harvesting is important for the regional and local hydrological cycle, it has been neglected as a result of technological development, paved and built urban areas, and a reduction in groundwater recharge areas in many developed countries[90]. The quantity and quality of ground water both improve as a result of rainwater harvesting. Rainwater collection is a sustainable way to address the world's water shortage and could support various water management strategies.

The responsible authority should immediately take precautionary measures to stop sewage and industrial discharges from contaminating groundwater supplies[91]. Numerous indicators of the quality of ground water can be analyzed using the water quality index. It is possible to analyse the impact and improvement ground water quality. Pumping rates, hydrogeology, geology, ground water heads, and a sensible balance between freshwater and saltwater flow all have an impact on seawater intrusion in coastal areas. Ground water can be recharged by infiltration to solve this problem. The infiltration will have a different impact on recharging ground water for various areas, particularly in coastal areas[92]. The process is influenced by a number of variables, including groundwater hydrochemistry, rainfall, soil depth, soil hydraulics, geomorphology, and climatic characteristics.

To calculate groundwater recharge potential zones, a variety of classes of thematic maps can be built using remote sensing and GIS techniques. For the purpose of making decisions about groundwater management, different data sets can be analyzed convergently by using a GIS platform to combine remotely sensed data and field survey data. SWAT simulated recharge rates and the spatial distribution of the hydrological properties of unconfined aquifers can be used to evaluate the potential recharge zones[93].

2.6 QUALITY OF WATER

Ground water quality and ground water tables are continuously reducing because of the agriculture and urbanization wastes, industrial waste, raising the possibility of quality deterioration and contaminating the aquifers that supply potable ground water. Pesticides and insecticides have been overused and heavily applied, contaminating the subsurface environment and rendering many sources unusable. When contaminants spread over large areas of the aquifer, ground water becomes unfit for use in a variety of applications. Soil salinity is one of the most crucial elements that influences agricultural production, particularly in irrigated arid areas. Anthropogenic and geological processes are also to blame for the huge level of arsenic mineral and fluoride detected in the potable and ground water[94]. Complex system of planate with solid, liquid and gas. For all kind of biological activities, water is very necessary and essential things in universe and thus life is not possible without water. Water is very kin for the all kind of activities happened on the earth surface as it needed in complex formation, biological processes and individually for the existence of the life[95]. In the past it was indicated that the sagas of army may struggle for the fresh water and in Priests & Monarchs have worshiped and blessed for good health.[96]For food security and life security, water ranked first and looking to present scenario, it has been shown that consumption and need of water will increases day by day and also seasonal changes take place so it is everyone's responsibility to use it carefully. Among total quantity of available water, only 2.5 percentage water is useful as the potable water and this water is also available in the form of glacier in polar region[97]. Water in the glacial region is available in huge quantity. There only rare creature is available who survive without water but apart from that everyone need water for their survival[98]. Water is very significant in the development of living organism and crucial part to equipping them[99-101]. development of civilization, is based om water and its important can be retrived[102]. In the modern age it is till unanswered that the life is possible without water gets polluted result in to several disease such as cholera diarrhea etc, born sickness typhoid and many other so its very importance to use the fresh water for drinking purpose as its pollutant free[103-105]. Ain altogether it says that its responsibility of all peoples as well as government body to work on this challenge and various department are associated to work on this[106-109].

Gandy purposed "reasonable water condition, at a rational price'', is a reachable propositial[110]. If proper safety is not taken then there might be challenge penalty therefore the honors of all those company or associated body should turn out to be alert & take fast action regarding this issue. It has been pointed out by many worker about the resposbility of parents of autism children to provide fresh and pollution free water to their chlidrens [111-113]. This article writer rather than having the capability in personality one should applicable the public skill as a great deal as probable so as to decrease the contamination such maintenance of purity, hygiene etc.[114]. Possibly main significant solitary step in a water-possess planned is to become its ongoing: in republics anywhere Hill[115]and Jackson[116] have recommended total quality management and organization framework based on information system. Close evolution is done by author of article how the technological factor can be cooperative to put into practice any of the plans that help in decreasing water pollution[117-119]. Extensive literature indicate that many areas are misplaced; but passable orientation and bibliographical works is assumed to allow the fitness measures to pursue out the essential to allow permit the sanitary or civil engineer to create strategies & mathematical projects for water-stream connections[120,121]. The thoughts offered in this article. Grown as a consequence knowledge composed from many areas of the universe. They are founded on the firm belief of the biographers as below:

1. Just by arranging a supply of ideal potable water more health benefits can be reached to common man rather than expending on other programs[122].
2. Without proper and adequate water supply large healthy benefit can be reached to population[123].
3. Water programmed can be rune very smoothly by a key factor called sanitary (or public health) engineer[124].
4. Health governments would take potent attention and to do required part in the elevation, accomplishment and organization of country water stock systems[125].

Authors of the articles have examined the water quality and have also closely examined the sanitization along with very good amount of data. They also have an expectation that the article can take place in WHO (31 monogram no), Composting & 39 No. Excreta discarding for local areas and tiny Societies as additional link in the shackle of capability being produce by the WHO to inspire conservational hygiene programs at the native level in associate States[126-128].

Mr. E. G. Wagner conscripted the initial text including specific features of country water-provisions, a short-term advisor to WHO, & was initiated in 1955 as a mimeographed article. The whole article was completed scanned by 40 specialists in various area of world for their appreciated suggestions and comments. Out of 40 an escalating response was found from 38, & has been of prodigious support in the adjustment and alteration of the source 01[129,130]. The assessors were acknowledged by the WHO[131]. The Servitor special de sazide pziblica of Brazil & the organization of inter American. Airs & operates were also acknowledged by the WHO for creation obtainable their vast knowledge & for their forthright & obliging censure of the solid[132]. Water is the most valuable offerings of the Mother Nature to mankind; the terrestrial ecosystem cannot function without it. All life and tangential potency are possible with no water[133]. More over to portable & individual health, water is compulsory for industrial, agricultural crop and manufacturing method, hydroelectric power production, recreation, waste assimilation & wildlife etc.[134, 135] when a source is applicable for so more diverse things, it is key that its growth & applicable sensibly and professionally. From very initial, man fills the potency and requirement of water for their routine life for this water is known as life & it has been recognized as nectar[136]. Water is extremely elementary to life. One cannot imagine a form of life that might exist without water. On the surface of the earth, water, in the form of oceans, seas, glaciers, freshwater bodies, rivers, wells, lakes, etc. occupies about 71.00 per cent of the area while, the landmass occupies about 29.00 per cent of the area[137, 138]. Assuming that 71% is as 100% then 97% is the seawater that is salty, while remaining 3% is portable fresh water. Polar ice possesses approximate 2% water & less than 1% water is detected in the appearance of groundwater and lakes. If we move from side-to- side data of water applicable 79% is applied for irrigation, 23% water for company & approximate 8% is applied for domestic things[139]. Groundwater is key source but unluckily prone to infectivity by materials harmful to human health[140]. In many areas of the world, infectivity is so high that the water is in poor condition even for agricultural use. Pollution levels of the ground water in densely populated are reached so high because of continuously withdrawn of ground water and formation of absorption pit. As this resource becomes more contaminated and scarcer, demand for high quality water will continue to grow making groundwater even more valuable and protection more important[141, 142]. Water sources are there for drinking and various journal uses must have high degree clarity free from all types of pollution[143]. The source and quality of bore well water is a clip resource and easily available source of our life. Is getting polluted due to population increase and industrial use[144]. Majority of the remote residential group of people i.e. group of people residing far gone from the urban region i.e. advise region mainly not receiving safe portable water. They don't have safe water provide so the citizens are compiled to take water from other source that have close to their town. In the majority of isolated tribal region bore well water is taken for portable water & other things. Bore well water is clean & it is not probable to blemish it but the chief production of bore well water's contamination is the application of fertilizers, chemicals, pesticides, lime; manure etc.[145-147].

Bore well water is normally applicable for drinking & other application in this region. The application of fertilizers, chemicals, lime, manure, 10 refuse dumps etc. are the major source of bore well water's contamination. There is no clean water provide for the populace livelihood in this region, so it applicable bore well water for its general & drinking things. We have noted the physico-chemical analysis of bore well drinking water considering water at some amount. Fluoride is present in all-natural water at some amount. In spite to life form small and big concentration of F^- can happen reliable upon the kind of rocks & the incidence of the F^- possessing raw materials in surface water. Widespread of steamy climates one more name of fluorosis has been explained. The major sources of F^- intake are water. Many inherited problems like cancer and goiter have been related with attendance of high level of a chemical or its derisory resource of water. Opinya et al. have cited that high or low level of F^- ions level in water as the main reason for dental fluorosis. Low concentration of iodine in Homo sapiens results in goiter. Little children have been noted as a potential high-risk group to the toxic effects a sodium for drinking water. Now a days about 18% of the world population do not gate pure drinking water and more than 4.5 million people lose their lives every year from illness connected with pure drinking water and scarcity sanitation services. If everybody acquires secure drinking water & high-quality cleanliness amenities there would be 198 million less harms of diarrhea & 2.0 million deaths happen by diarrheal problem per year. Biofilms are including of inorganic and organic substances in piping that can water front, defend and permit the explosion of various bacterial pathogens, covering legionella & mycobacterium avium compounds (MAC). Sources infuriate bacterial progress on Biofilms have water temperature altered sterilizer and remaining concentration, ecofriendly animal C level, degree of pipe deterioration and kind of circulation system chloramines are meaningfully powerfully operative than chlorine for monitoring legionella in Biofilms distribution system deficiencies linked to a number of water born disease outbreaks**.** The advantage of an optimal neural channel model for prediction of water quality parameters based on few known parameters is implemented in this work. The empirical formula was taken from the Department of Natural Resources, New South Wales (NSW), and Australia**.** The conclusion of the model was encouraging. The comparison of the NSW model, actual experimental results and regression models are also appended. These replicas are working by the expert whichever since it is imperfection in terms of period and/or area to collect evidence to kind the estimates than to cover the material round the occurrence itself, or, additional prospective, since the incident to be prophesied will take place in some impending time. Abundant of the western United States is semi-arid, requiring significant irrigation to grow common crops. Improvements in pump technology during the 1960s made groundwater wells easy solution for satisfying crop requirements. However, by 1989 significant groundwater level reductions of up to 30.5-m (100-ft) were observed in parts of the High Plains aquifer (also referred to as the Ogallala aquifer for its geologic formation) underlying the states from South Dakota to Texas. Reductions in stream flow have had negative impacts on aquatic habitat resulting, in some cases, in the extirpation of fish species from western rivers. In Colorado, his disappearance of habitat is threatening the Brass Minnow (Hybognathushankinsoni), throughout the Arikaree River which is a stronghold for this species particularly along the Nature Conservancy's Fox Ranch property along the Arikaree River.

Groundwater models often are used to investigate water rights or to estimate habitat recovery. The assumptions made during the modeling process are very different depending on which of these goals the modeler is trying to achieve. Modeling for habitat recovery projections requires the modeler to assume conservative estimates of flow recovery (under estimation) because over estimation could mean habitat is actually not available where projected. If a given species were to require the area of habitat recovery projected in the model for survival and it were not available, there may not be enough time to remedy the situation. Conversely, underestimation of stream depletion causes legal problems when modeling to establish water rights because a user may be imposing on a senior right held by another user. The distinction is important and the purpose of a model must be established before it is used for any work.

2.7 CONCEPTUALIZATION

One of the main contributions of this thesis was to derive a conceptualization of the Shedhi and Vatrak rivers water cycle and groundwater system. River water is important surface water sources which obtains water from rains water. This water and ground water gets contaminated by an industrial waste so, the ratio of ions and dissolved Oxygen which is supposed to be present in the Ground Water and Surface water change abruptly and is the serious problem for human beings as well as water bodies leading to water borne diseases. People in developing countries are so aware of such quality of the water of these water bodies and deterioration of soil, fast creating social, economic and technological problems. The different physical and chemical standard methods were used for water samples analysis. Specification of drinking water, Bureaus of Indian standard and practical method of water analysis was studie also as prescribed by APHA (1998) adopting physico chemical analysis of water, metal concentration and organic compounds.

2.8 BACKGROUND OF STUDY

The present level of nitrate obtained from surface water sample collected during monsoon and the same process had been done after monsoon season and was found below the safety limit in the remote aquifer which was used for drinking water. Yet, total dissolved solids are more than potable limits with increasing trend nearby bank. The reasons for inherent salinity was attributed to sea water intrusion. These water pollution problems of ground water distribute them in different way in the localities because of recent social in equities. For example, rural people used some hand pump has failed, there for, they had to get lower quality water from open wells. The practice of water clearance system and the awareness for using the pure water are highly variable ranging from homely rivers osmosis system used by rich urban people and NRI donated society based in village area to simple filtration spread acidly in rural areas. Developing the methods of monitoring of the water source will increase awareness in society people will get pure water in this area.

Nowadays, the eco-friendly defense agency controls more than 80 downing water chemicals and the enormous people get consumption of water afterward. Governments are required consider the health issues related to pure water quality in the light of following points.

1. Current treatment may not be sufficient.
2. Populations are increasing and shifting geographically.
3. Speculation in study & progress has weakened.

Water is important for the existence of humans, animals & plants. Water is too home-based to a very broad range of micro vegetation & micro wildlife, generating a charming setting of dangerous organic significance. This entices too petite courtesy. Drinking water is evolving as one of the most serious issues which may finish humanity. Water is, accurately, the spring of lifespan on terrain. The human body is 70% H_2O. Human existences can endure for solitary a few days when deprived of fresh water. In future till 2025 however 45 countries are believed to fight with scarcity related round about 2.7 billion people, 34 % of worlds estimated population. Ethiopia, India, Kenya, Nigeria and four more are among the countries which can face the shortage of water in coming 25 years. There are few large nations like China, now a day suffers from ardent water problems. Hazardous public hygiene problems come out from dirty water, improper west disposal and improper water administration in most parts of the world. Every year lot many people lost their lives due to water born disease like typhoid, cholera and schistosomiasis harm. Wastage and spoil of water supplies also are heavy burden and the original environment, all pose increasing danger for many aspects life. The excellence and the amount of water are failing internationally as a consequence of fast population progress, urbanization & development. Most countries however currently are aware of the necessity of fresh water as a requirement for survival. Fresh water needs to occupy highest priority, on the international agenda. In addition to this the source of fresh water which is available to mankind is shrinking in effect because majority of fresh water supply have been near to extant or ended.

In number of countries, water bodies like ponds and rivers are used as container for very low level storage of wastes, untreated dump, poisons industrial wastes and dangerous chemicals that spread on the surface and same community depends on ground waters from farming. Many growing countries fight problematic assortment. The shortage of the fresh water is obviously to be unique of the protuberant influences, decelerating monetary progresses in future, officiating the ecosphere. Unclean and rare water goods are serious public health difficulties in abundance of the World. Poisoned water, aquatic scarcities & contaminated living situations slay over 12 million persons per year. Pollution is ubiquitous but certain industrialized republics have correctly pure water excellence and achieved water dis contamination. Many states don't have recited laws to mange water contamination correctly while others cannot place to perform water excellence level. International growth society requirements for the evolving systems need to pay additional courtesy to except and progress water transparency. To maintain the water base economic development and the quality of life, the well to do world also must use more energy.

In 1974, the Global Environment Monitoring System, GEMSIWATER program was introduce to boost up and to coordinate the all Elion of Environmental data, count wise, region wise and globally. While a EMS has established its goal to assist governments to develop system for their personal use and its other purposes are to make improvement in the validity and comparability of Environmental data globally and to make these data available for the collation and check the environmental data. Prior program was found one for climate related monitoring, monitoring of natural scares, monitoring of seas and monitoring related to us given in GEMS, WHO, UNESCO, WMO, and UNEP established GEMST water quality projects? The goals of the projects are to combine with member nations in the planning of new water monitoring systems and to empower present ones to improve the validity and comparability of water quality informality. Among nine nation members which were to judge the incidence and longtime ways of water pollution by chosen persistent risky substances.

The open up idea of the global water quality monitoring project is that the member states take active participation and regularly keep an eye on the quality of in hygienic substance in water resources at selected local place and find out the information for global synthesis and broadcasting. Wherever possible, the location for the global channel was chosen from present national or local channels. New locations were founded where such locations did not exist. Water bodies (rivers, ponds and ground water aquifers) were of main concern. Which is meager source of water supply for industry, animal's agriculture and people. So many locations were also added to monitor global rives and lacks, seas and water bodies not affected by human activity till now. The goal for the first part of the project (1977-1984) was the abolishment of a complex network of approximately 300 monitoring stations on rivers, ponds and an ground water qualities. At the same time, it was decided that total of about 1200 locations might ultimately necessary to cop up with representative global coverage. Drinking of water quality may vary at these locations, inclined natural, and a tropogenic constituents. The period between 1977 to 1979 was a primary please during that time guidelines, specialists were trained in various areas, universal centers were introduced. In collaboration with government, national institutes were identified and named as the focal points for EMST water activates, within each country. Laboratories were established to do the regular sampling and analysis at the chosen monitoring sites. WHO implemented GEMS water Geneva with the guidance of WHO regional office WHO regional centers for environmental hygiene also provided technical supports more over institutes have been founded as regional reference laboratories for using the analytical quality assurance component of the project. The global data center is situated at the Canada center for the in-land waters, Burlington. Surface and ground water quality and a UNEP GEMS combining center for clean water all serration and checking. The Environmental observation and help laboratory Cincinnati of the U.S, Environmental protection agency serves as the global center for analytical quilter control. UNESCO has taken part in the field of training and assessment mythology. WHO has aimed network design criteria and hydrological monitoring system. The primary phase of project has indicated to the fulfillment of a basic monitoring channel. General operations above intimation flow was found for mast locations during 1978 to 1979. The GEMSNATER provided required technical formalities. In carnations to operate used in all laboratories and organizations as the prime insertions for their monitoring programs. As a certain level of general monitoring and information reporting achieved, it was considered timely to combine project ends in the form of three publications all which were found out in 1983.

1. GEMSNATER Directory of Participating Institutions (1983).
2. GEMSNATER Data Summary 1979- 1981.
3. GEMSIWATER Data Evaluation Report 1983.

Nutrient Contamination Agriculture methods, the largest supplier for water contamination even supplementary to municipalities and industries. Effectively in all nation, where agricultural manures and insecticides are applied, it was observed that infections of ground water possess well surface waters. Another source of contamination in few areas is by subconscious trashes. The spinal water in to rivers & coils are afterward utilized for agriculture is frequently of deprived superiority with more presence of nutrient, pathogens, salinity and residues. America and Europe face countless water contamination higher than 87 % of Europe's rivers with high nitrate from insecticides & 6 % of which possess round nearby 198 times more than nitrate levels that occurs in clean rivers**.** Most of the Europe's ponds are entropies from full of farming and municipal nutrients. It we want to know what eutrophication is them it is a method that occur when additional nutrients block the development of algae which once die & decay, raid the water of oxygen. Although mineral salts of low pollution relevance are the most common constituents found in ground water, some serious pollutants and pollution levels also can be detected. UNEP (1998) noted that 80% of ground water samples in Sri Lanka contain nitrate levels above the drinking water standard of 10 mg liter. The primary source of NO_3-N in ground water is leaching from soils. Shrivastva et al. and Saxena have reported the leaching of nitrate ions from the soil into ground water. Nitrate itself is relatively nontoxic but when ingested with food or water it may be reduced to nitrite (NO_2) by bacteria present in mouth and gut. If nitrite containing water is utilized for drinking purposes it can react with secondary arsines present in the human body, and may form carcinogenic nitrosamines. High levels of nitrates poses a health problem and can cause infant methemoglobinemia (blue baby disease) and cancer. Nitrates affect young babies (less than three months old) by depriving them of oxygen. Health problems due to nitrates present in water foundations have achieved a thoughtful state practically in all nations. In overview, about 145 nations have problems of nitrates from manures. Elusive concentrations of phosphates and nitrates in water create progress of blue green algae, causing to eutrophication (deoxygenating). Oxygen is needed for the breakdown of the bacteria that help as cleansers, which break down organic matter infecting the water. Therefore, the quantity of oxygen controlled in water is a key gauge of water excellence. The use of agricultural chemicals (nitrate -nitrogen fertilizers and pesticides) and their occurrence in groundwater. Showed be probably monitored time to time. The concern over the toxicological hazards caused due to pesticides is growing over the last three decades.

The extent of groundwater contamination from both nitrate - nitrogen and from a range of pesticides has been discussed on the basis of numerous surveys throughout U.S.A. Technologies available for removing these chemicals, to acceptable drinking water levels are outlined. Several different drinking water treatment methods, involving both centralized treatment and individual household point of entry devices, were evaluated through case studies and field - scale research projects in Suffolk country, New York, and in California. Processes available for the removal of nitrate from drinking water were reviewed presenting their strengths and weaknesses. The processes were ion exchange, reverse osmosis, electrolysis and biological denitrification. A combination of biological denitrification and electro dialysis is available offering such benefits as conversion of nitrates to nitrogen in continuous operation. It is suitable for flows above 300 m3 per day and with a nitrate concentration of 50 - 100 mg/L. Ground water Pollution has been found in many areas of the world where groundwater is the primary drinking water source. Many factors affected quality of ground water such as physico chemical characters of the rocks through which the water is circulating, geology of the location, climate of the area, role of microorganisms that operate for the oxidative and reductive biodegradation of organic matter, intrusion of saline waters as in coastal areas, etc. Ground water constitutes an important part of many water resource systems, supplying water for domestic use, for industry and for agriculture. At present, nearly one-fifth of all water used in the world is obtained from groundwater resources about 14.5% of world's crop land is irrigated by groundwater. The present irrigated area in India is 60 million hectares (Mha.) of which about 38% is irrigated from groundwater**.** Surface water acts as a source due to of long pore interplanetary in earth supplies, as a channel that can carriage water, completed a long detachment, & as a powered filter that recovers water superiority by eliminating deferred solids & bacterial adulteration (Sharma, 1996). In Europe the delinquent of surface water pollution is deteriorating. Approximately, 58,000 square kilometers of surface water aquifers in cowboy movie & dominant Europe are intended to be polluted with insecticides and manures. Of Hungary's 1,500 area wells patter surface water, 550 of them are previously polluted, widely with cultivated chemicals (Havas- Szilagyi, et a1. 1998). In the Czech Nation 70%-of all external waters are severely contaminated, typically with civic and manufacturing wastes. About 28% of the nation's streams are so contaminated with impurities that no angle endured (Nash, 1993). In US, 38% of all external waters are not appropriate for swim or trawling, and 50% of all pools are emaciated (US EPA, 1998).

Germany has accorded high priority to ground water protection where over 80 per cent of the public water supply was taken from groundwater, including artificial recharge and bank infiltration. However, despite legislation, groundwater pollution was increasing, particularly in agricultural areas. Hence limits have been introduced for pesticides levels and new rules have been ~introduced governing dumping and storage. River Contamination higher than partial of the World's main rivers are extremely useless and contaminated, humiliating the nearby ecosystem, therefore intimidating the persons who utilize the identical water for irrigation, consumption & commerce for the fitness and maintenance.

Pollution is multifaceted in emerging nations, where the people are swelling fast, growth required are snowballing, & establishments have different outlay urgencies. Nearly 73 % of all manufacturing dump & 91 % to 94 % of all national manure are probably water which people for pollution free water. In Malaysia and Thailand, water contamination is so high that streams often comprise 31 hundred times higher pathogens weighty metals & toxic materials from business and other anthropogenic activities. In China, the 50,000 km long rivers of length 33000 km are so contaminated that fish cannot live in. In 1992, Porcelain's businesses distributed 36 billion metric tons of administered natural sewage in to water ways of coastal & lakes water. In 1986, the Liao River, transitory to very extremely developed north part of China in which virtually each water animal indoors at 100 km was perished when over 1.1 billion tons of manufacturing dumps were discarded in to the stream within 3 months. In higher Saopaulo, Brazil, 259 ton of natural wastes from 1200 industry were dumped in to Tiete River everyday & the river is dead. Accordingly, the river possesses very high limit of cadmium, lead other heavy metals. The city too heaves few 900 metric tons of junkyards in the streams daily of that only 11% is measured. Pakistan's biggest town Karachi has completely out-dated manure method plants so the urban is whelmed over with the junkyard. These florae now & they function less than 14% of volume because of disruption down & ploughed pipes. Most of all the drains water seepages out were hooked on the nearby soil, pampering the bores water utilized by folks for drinking purposes.

More than this, toxic materials such as SO_2, NO_2 which in the atmosphere reach to form in the farms of acid rain and create negative effect on both, drinking water and soil Ecosystem. Acid rain decreases the pH of rivers and streams. If do not buffered by calcium acidified waters kill many types of fish, man and trout. Synthetic chemicals behaved like a very dangerous material. Throughout the world, about 65.000 various chemicals are in regular use. Per annul an estimated, 1000 new substance are found out. Many of them go in to rivers, ponds and ground water aquifers. More than 650 substances have been found out in fresh water, 125 of them were highly poisonous in U.S. alone. Many synthetic chemicals, are recognizing as persistent organic pollutants among halogenated H.C, dioxins and organochlorines such as DDT and PCBS, they live long and are very poisonous. They cannot he controlled easily by natural process and consequently accumulate in the biological tool sequence, until they create danger to man kinds hygiene.

Water based epidemic creates tragedy for mankind. They kill so many of people every year, they prevent more people from living healthy lives and resist development efforts. About 2 billion people have diseases that are due to polluted water. More than 54 % children's life is concern with infections and parasitic diseases which are water related diseases. In both, aged people and children, water related diseases creates a high proportion of all illness in some coronaries. Whereas water-based epidemics substantially in their nature, traveling effect and negative health effects based on water can be managed by three ways, water related disease including those due to both, fecal-oral organisms and those because of poisonsous substance. Water related disease and water related vector diseases. Produce another level water-scarce disease, that creates where pure drinking water is not available. Water borne diseases are "polluted – water" diseases those because of the water which has been polluted by mankind, industrial wastes and creatures. In the whole world, there is no system of sanitary derange disposal and viability of pure drinking water is not there which causes for over millions if deaths water borne epidemics are like cholera, typhoid, polio, meningitis and hepatitis A and B. The bacterial, viral or protozoa organisms becomes guest in human beings and make reasons for these diseases. Most of the people don't have any way to sanitary derange disposal or to cure water for personal hygiene. More than 1.3 billion people are under the risk area from health view point as they don't have pure drinking water. Water borne diseases grow fast because there are no proper sanitation facilities. The limit to which epidemic organism take place in pure water source depend on the population, waste disposal, etc. that they have. Disease is present in those countries where more improper sewage process is are there. It is believed that 4.1 billion cases of diaries disease take place every year, causing lot many deaths, mostly among children.

Epidemics of disease like cholera are spread out because of using contaminated dump as fertilizer. For example, in early 1991, unrefined manure water that was moistened to improve plant produced cholera in Peru & Chille. An employee community in Buenos arias, (Argentina) confronted gratified unhealthy of hepatitis, cholera & meningitis because only 5% of house had pure water or good toilets. Alongside, indecorous food & less handiness of medical facilities irrupted the cleanliness. Water -borne illnesses are all around, due to materials that discover their way into lake. Progressively, chemicals, agricultural, fertilizer, pesticides, and manufacturing wastes are actually detected in freshwater materials. Few chemicals, uniform in low level, can produce over spell & therefore can give are root peril diseases like tumor amongst publics that usage the water. In agricultural Insecticides such as DDT & heptachlor are applied, which were applied in undeveloped, often current hooked on the irrigations water. In Bangladesh, (Dhaka), heptachlor remains in aquatic sources have touched as tall as 0.789 micrograms per liter-

22 times higher than WHO- counseled highest of 0.03 micrograms/liter. Throughout the rainy period in Venezuela, the aquatic system was polluted with a several insecticides. The leakage of toxic contaminants into crushed and superficial water pools applied for ingestion and national utility produced health difficulties in manufacturing countries. Health of plump near 450 million persons is in the danger in Europe & Russia because of water contamination.

Water pollution possesses heavy metals, a repetition that assistant to clarify high child mortality rates and widespread diarrhea 1 and duodenal diseases connected there. In Northerly Russia, half of a million persons on the Peninsula, Kola, from downstream & upstream site in the Hanford reach, Columbia, Washington, are affected. Rivers, were inspected and found twelve water excellence variables for the period 1951-1953 & 1963-1988 to identify any important fluctuations that have befallen over a 35- year interval. 1951 - 1953 period's higher beta radioactivity and water temperatures were observed arising from 5 single-purpose production, 26 reactors which operated until 1971. In the early period, sulphates and dissolved oxygen (DO) were also meaningfully lower downstream throughout. The beta-radiation and aquatic temperatures were alike for downstream and upstream through 1986-1988, but nitrate, nitrogen had become meaningfully developed downstairs. Phosphates had diminished suggestively finished the 35-year pauses, though DO, BOD & nitrate nitrogen had amplified by a trivial gradation.

Industrial wastes are the supplementary source of arsenic pollution. In sewages from the manufacturing, ceramic and glassware trades, pesticide and dye engineering businesses, firewood sanitizing, rare earth business & other inorganic and organic chemical businesses, arsenical and arsenic complexes are originated. Maximum pollutant level for arsenic in water has remained set 50 mg/L by Joint States presently. Canada has previously dropped the supreme pollutant level to 25 mg/L; due to the tumor risks. Numerous handlings systems have been implemented to eliminate arsenic from drinking water. Government of west Bengal has given permissible limit (0.05 mg/L) of arsenic in groundwater, but it was found above the maximum in six districts, in India; 30 million people reside in these six districts have an area of 33,000 km. Based on a survey of these affected. Areas of arsenic toxicity districts, it was estimated that at least 750,000 people could be drinking water high in arsenic with more than 175,000 people showing arsenical skin lesions which are at the advanced stages. Major source of arsenic pollution is geological.

2.9 OBJECTIVES OF WORK

1. To estimate the quality of underground water of some representative areas of two taluka such as Ankleshwar and Bharuch of Bharuch district.
2. To characterize the different types of waters in terms of pH, hardness, total alkalinity, Fluoride, Phosphate, Chloride, Calcium, Magnesium, and Nitrate, COD, BOD, total alkalinity, Temperature, dissolved oxygen (DO) total dissolved solid (TDS). etc.
3. To establish inter-relationship between different parameters of same regions in during three seasons, such as winter, monsoon and summer.

2.10 IMPORTANCE AND FUTURE SCOPE OF RESEARCH WORK

In the proposed research work, 30 stations of two taluka (**Ankleshwar and Bharuch**) were selected as given below.

Entire thesis covers the physicochemical analysis of ground water collected from 15 stations of Ankleshwar taluka such as Sarthan, Telva, Piludra, Umarwada, Jetali, Piprod, Avadar, Pardi Mokha, Sangpor, Kosamadi, Panoli, Kharod, Motali, Andala and Utiyadara.

The presenct work also covers the physicochemical analysis of ground water collected from 15 stations of Bharuch taluka such as Adol, Amdada, AmLeshwar, Bambusar, Bhuva, Cholad, Dabhali, Ghodi, Haldar, Karela, Kelod, Osara, SamLod, Segva and Shahpura.

Above analysis can also create opportunities for the researchers to enhance their work to improve the quality of ground water of the mention area.

2.11 APPLICATION OF STUDY TO SOCIETY

- Bharuch district is in between Vadodara and Surat industrial city so analysis of physical parameters of water is necessary to health point of view.
- Community is facing so many problems related to digestive system, cancer, lung irritation due to drinking of poor quality water so it provides scope for monitoring quality of water.
- Investigation of physico-chemical analysis of ground, surface and river water of Bharuch region in terms of concentration of ions like phosphate, chlorides, calcium, magnesium and nitrate, COD, BOD, total alkalinity, temperature, pH,

dissolved oxygen (DO) and total dissolved solid (TDS).

- All the parameters were measured in Winter, Summer and Monsoon seasons.
- All data were compared with standard data and our target is to make peoples of these regions aware about quality of water they are using and perform some need base work to improve the quality. Water analysis of different places was carried out with respect to different seasons and to check data variation in accordance with previous one. After assessing the water sample for their quality, the research may also be enhanced by modifying the different techniques to purify the water sample.

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CHAPTER – III

EXPERIMENTAL & METHODS

CONTENTS

This chapter deals with experimental data of water analysis in terms of pH, hardness, total alkalinity, fluoride, phosphate, chloride, calcium, magnesium, and nitrate, C.O.D, B.O.D, dissolved oxygen (DO), total dissolved solid (T.D.S) etc. of two Talukas of Bharuch district with 15 stations in each Talukas. Data obtained in three seasons such as Winter, Monsoon, and Summer are given in chapter-4.

3.1 GENERAL INTRODUCTION

This chapter deals with the collection of samples of Ground water from Ankleshwar and Bharuch Taluka of Bharuch district with 15 stations in each Taluka in three different seasons such as Winter, Monsoon, and Summer and their analysis.

As the rain fall is uneven from past few years, the potentials of small/seasonal rivers affect the ground water in different ways. This can make a large change in property of ground water, which could be temporary or permanent and hence the property of ground water turns poor.

Groundwater system is polluted by natural activities as well as human activities such as: Pollutants dumped on the surface of land comes in contact with percolating water of rain which make the soluble part dissolved in them and picks it up to the aquifer. The boisterous of surface water pollution in various levels of the nation has become so severe that if crucial ladders for reduction are not adopted surface water capitals may be injured.

Groundwater property depends on number of factors such as:

1. Number of hydrological factors: Variation in seasons
2. Number of physical factors: Type of soil, moisture content etc.
3. Number of chemical factors: Soil pollution by Industry and constitution of upper crust of soil.
4. Number of biological factors: Surrounding Plant Kingdome and animal Kingdome.

It is generally found that the groundwater has more dissolved constituents as compared to surface water as it is more in contact with different types of materials than surface water. As the constitution of soil varies from point to point, there is vast difference in constitution of groundwater. Potable water should ideally be free from toxic elements, dissolved minerals in specific limit; some heavy metals in specific limit for example

Cobalt, Copper, etc. The foremost serious problem is the increase in fluoride content in ground water leading to the disease called Fluorosis. Most of the peoples using ground water for the drinking purpose, so it's necessary to know about the quality of the ground water, suspended solids and impurities. Here, in present work we have selected two talukas, namely, Ankleshwar and Bharuch of Bharuch district, Gujarat with fifteen stations in each taluka with respect to three different seasons Winter, Summer and Monsoon.

3.2 SAMPLING

Two different taluka of Bharuch district with 15 stations were selected for each taluka for the physicochemical analysis of ground water with respect to three different season such as Winter, Summer and Monsson. Quality of ground water was determined in terms of measurement of physico-chemical parameters such as concentration of different ions like chloride, fluoride, nitrate, calcium, sulphate and magnesium, pH, Chemical oxygen demand (COD), Biological oxygen demand (BOD), total alkalinity, dissolved oxygen (DO), and total dissolved solid (TDS). Water samples collected from tube well, open dug, hand pump etc. from the different stations namely Sarthan, Telva, Piludra, Umarwada, Jetali, Piprod, Avadar, Pardi Mokha, Sangpor, Kosamadi, Panoli, Kharod, Motali, Andala, Utiyadara, Adol, Amdada, AmLeshwar, Bambusar, Bhuva, Cholad, Dabhali, Ghodi, Haldar, Karela, Kelod, Osara, SamLod, Segva and Shahpura in 2.5 L precleaned glass sample bottles.

3.3 EXPERIMENTAL

Total Dissolved Solid (TDS)/ Suspended Solid

Principle: - TDS is nothing but combination of dissolved solid of true solution and combined solution called pseudo solution.

Suspended Solid: - This type of the solid can be removed simply by the filtration using appropriate size filtration device and organic suspended solid can be simply removed by choosing appropriate filter paper and funnel.

Dissolved Solid: - Salts such, sulphate, nitrate, bicarbonates and chlorides of calcium and magnesium are crystalline can be removed by filtration using glass funnel and filter paper or upon boiling of the amounts of salts in liquid and calculating the liquid left behind. In majority of cases when samples are dried at temperature 102-105°C but in some of the cases, it may dried up to temperature 130-170°C results in to removal of few organic compounds, Nitrate and Chlorides in addition to bicarbonates gets converted to carbonates that's why exact TDS determination is not possible.

Procedure: -

(1) Total Dissolved Solid (TDS)

For determination of total dissolved solid in the sample G4 sintered funnel was used for the removal of the organic impurities and other suspended solid followed by preparation of sample in the 100 mL previously cleaned beaker (pre heated at above 120°C temperature and suddenly cooled down to room temperature). Sample was evaporated using steam bath at temperature around 100°C till the constant weight was observed at least for three times in the oven. steam bath (102-105°C) was used till constant weight was recorded for 3 times followed by cooling at room temperature and weighing it calculation was done as per the formula given below

Calculation:

$$\textbf{TDS (mg/ML)} = \frac{[(\text{weight of beaker + Residue})\text{-}(\text{weight of empty beaker})]}{[\text{Volume of Sample taken in mL}]}$$

(2) Total Suspended Solid (TSS)

To find out suspended solid in water determined by taking sample in G4 funnel preheated at temperature 120°C and filter it using What man filter paper followed collection of filtrates in the beaker. Solid collected in the form of residue on filter paper were washed with the double distilled water. The solid collected over the funnel/paper were washed with double distilled water and deride at100°C temperature and weight out.

Calculations:

$$\textbf{TDS (mg/ML)} = \frac{[(\text{wt. of funnel+filter paper+residue}) \text{-}(\text{wt. of empty funnel/filter paper})]}{[\text{mL of sample taken}]}$$

(3) Total Solid: -

To determine total solid in the water sample, water is collected in the previously dried beaker at 120°C temperature and was placed in oven at temperature 170°C till the constant weight is recorded followed by allowed to cool at room temperature in desiccator for long time. Sometimes solid dried at room temperature may absorb moisture due to hygroscopic its nature

Calculation

$$\textbf{TDS (mg/ML)} = \frac{[(\text{Weight of Beaker with residue})\text{- (Weight of empty beaker]}}{[\text{Volume of Sample taken in mL}]}$$

pH Measurement

Principle: - Using these methods one can determine whether water is acidic or basic in nature. Mathematically, pH is determining by measuring concentration of hydronium ion.

$$pH = - \log[H_3O^+]$$

This assembly made up of two components such as glass and reference electrode:

Glass Electrode: - It is type of voltmeter which is sensitive towards H^+ ion concentration. Key role of this electrode is to separate standard 0.1M HCl solution on inner side of glass electrode and sample solution on outer side of glass electrode using thin glass membrane. Electrode is made up of silver road coated with silver chloride which is represented by Ag/AgCl. Potential is depending on concentration of acid solution.

Reference electrode: - This electrode is nothing but silver metal is in contact with d silver chloride dipped in 0.1M KCl solution surrounded by glass tube having porous fiber to conduct electricity. Potential difference is created between potassium chloride and sample solution.

Note: for calibration, the buffer solution with pH 7.0 was used and tap water's pH was found between 6.5-7.0.

Procedure: -

First, the pH meter was started and kept for 5 minutes to stabilize and them followed by calibration using buffer solution of pH 4.0 and 9.2 (Acidic and basic respectively).

Temperature was kept constant throughout the experiments and the 10 H of water sample was measured after properly dippy the elects in the water sample.

Total Hardness

Principle: - Water is hard due to presence of satts of calcium and magnesium. Presence of hardness is mark by slat formation while using as the coolant. Elimination of hardness can be possible by softening of water, ion exchange resin method, Electrolysis, etc. by removing hard ions, water become soft.

Complexometric method is available for determination of hardness in water sample using EDTA by formation of complex with Ca^{2+} and Mg^{2+} ions at basic pH using Eriochrome Black-T indicator. Color change appear from wine red to blue.

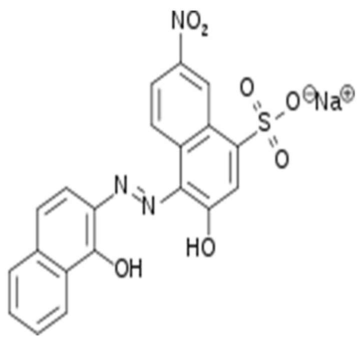
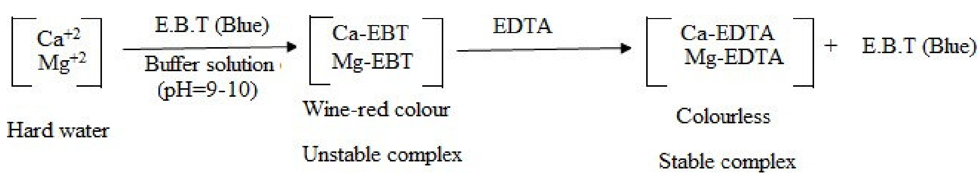


Fig. 3.3 Eriochrome Black-T [EBT]

Procedure:

Exact 50mL of water sample was taken in un 250 mL conical flask. 2-3 mL buffer solution of basic pH was added, followed by addition of Eriochrome black T as the indicator. The solution was stirred well and titrated it with 0.01M EDTA solution till the color change was observed from wine red to blue. The experiment was repeated for two more reading and noted the constant reading as the end point.



Calculation: Total Hardness

$$M_1V_1=M_2V_2$$

Where,

M_1= Concentration (Hardness) of water sample, V_1= Volume of water taken

M_2= Concentration (0.01M) of EDTA, V_2= Volume of EDTA

Hardness due to Ca^{2+}

Principle: Murexide (ammonium purpurate) indicator was used to determine presence of calcium in the mixture of calcium and magnesium using the complexometric titration with EDTA at pH greater than 11. At alkaline pH, magnesium is precipitated as the magnesium hydroxide and it does not interfere during the titration. Initially, pink color appears due to unstable complex formation of calcium with indicator followed by formation of new complex with EDTA which has purple color indicating the end point. The experiment was repeated for two more reading and the end point was determined.

Procedure: -

50mL of water sample was taken in the conical flask, add 2mL 1N sodium hydroxide solution was added at so that the pH becomes more alkali say 12. Now titrate the solution against 0.01M EDTA using murexide as the indicator. End point observed is color change from pink to purple.

Calculation: -

$$\textbf{\textit{Calcium hardness in mg/mL}} = \frac{\textit{Volume of EDTA Consumed in mL} \times 40.078}{\textit{Volume of water sample taken in mL}}$$

Hardness due to Mg^{+2}

Principle: - Whenever mixture of magnesium and calcium is present at that time there is no direct method available for the determination of only magnesium concentration but it can be determine using the following formula.

Magnesium hardness in mg/mL = *Total hardness - hardness due to Calcium in mg/mL*

Cl^- by Argentometric method

For any titrimetric method

(a) reaction must be completed i.e. $K_{titration}$ should be larger.

(b) Reaction must be fast

Precipitation reaction itself is the fast reaction process therefore for reaction of silver salt uses argentometric titration in which silver nitrate is used as the titrant. This method is applicable to analyze different negative ions which are capable of forming precipitates with Ag^+ ion.

Silver is precipitated as the silver chloride and silver nitrate is taken in burette and when it is added to water sample, then precipitation of AgCl take place, here potassium chromate is used as the indicator.

Ag^+(Burette) + Cl^-(Sample) → AgCl (↓) White ppts,

Ag^+(Burette) + CrO_4^{2-}(Sample) → Ag_2CrO_4(↓) Red ppts

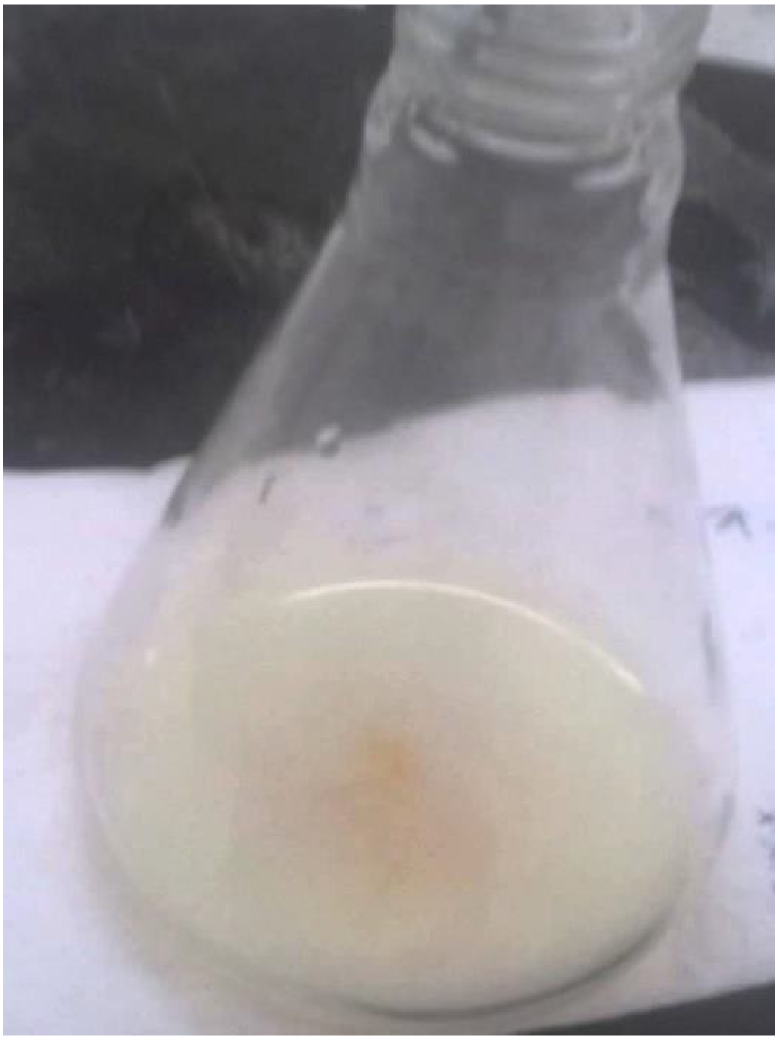


Fig. 3.6

But whenever there is a free chloride ion in the medium the red colour of silver chromate disappear because of the following reaction:

Ag_2CrO_4 (↓) Red precipitates + $2Cl^-$(Sample) → 2AgCl (↓) White precipitates + CrO_4^{2-}

Hence at the end point of the reaction; no free chloride ions are available, the following reaction takes place:

$2AgNO_3$ + K_2CrO_4 → Ag_2CrO_4(↓) Red precipitates + $2KNO_3$

Process:

Blank Titration (V_1): 50 mL deionized double distilled water was taken in conical flask, 2 mL 2N Potassium chromate was added to it and titrated against 0.01N $AgNO_3$ solution taken in burette. Experiment was repeated to get constant reading as the end point, called V_1 mL.

Sample Titration (V_2): 50 mL sample water was taken in conical flask, and 2 mL 2N Potassium chromate was added to it and it against 0.01N $AgNO_3$ solution taken in burette. Experiment was repeated to get constant reading at the end point, called V_2 mL.

Calculations:

Required volume of $AgNO_3$ for consumption of Cl^- present in water sample = $\mathbf{V_2-V_1}$ **mL**

= $\mathbf{V_3}$ **mL**

Concentration of Silver nitrate N_3= 0.01N

Volume of water sample taken =V_4=50 mL Concentration of Cl^-(**N_4**): can be determine as following

$$Cl^{-X} \textit{ concentration in g/mL} = N_4 \; \frac{N_3V_3 \times 35.49}{V_4 \times 1000}$$

Determination of sulphate ion by spectrophotometric method

Principle: - First standard plot of absorption of sulphate ion from known concentration of $BaSO_4$ prepared and same was carried out for the sulphate ion present in the water sample. By comparing both the plots one can measure the concentration of sulphate ions present in the water sample.

Reagents:

Reagents: In a 250 mL measuring flask 25 mL Glycerol, 15 mL conc HCl and 50 mL isopropyl alcohol and 35 g NaCl. mL was taken The volume of flask was made 250mLwith distilled water.

Stand. Solution of Sulphate ion 1mL = 1mg Sulphate ion: *It was prepared by dissolving 1.479 g anhydrous sodium sulphate in to 1000 mL distilled water.*

Preparation of standard solutions, sample solution and blank solution:

			Flask Number		
1	***2***	***3***	***4***	***5***	***6***
0.0 mL standard solution	*10.0 mL standard solution*	*20.0 mL standard solution*	*30.0 mL standard solution*	*40.0 mL standard solution*	*20.0 mL sample solution*
5 mL reagent	*5 mL reagent*	*5 mL reagent*	*5 mL reagent*	*5 mL reagent*	*5 mL reagent*
10mL $BaCl_2$ solution	*10mL BaCl solution*	*10mL BaCl solution*	*10mL BaCl solution*	*10mL BaCl solution*	*10mL BaCl solution*
85 mL distilled water	*75 mL distilled water*	*65 mL distilled water*	*55 mL distilled water*	*45 mL distilled water*	*55 mL distilled water*

Process:

Length wave of spectrophotometer was set to 420 nm. Instrument was calibrated by taking blank solution from flask number-1 in to photo-cell. The it was set to zero by measuring the absorption of both sample and standard solutions.

The absorption of standard and sample solution was plotted against concentration of sulphate ions. From the graph, one can know the required concentration of sulphate ions corresponding to absorption.

Determination of Nitrate ion by spectrophotometric method

Principle:

This method is only applicable when water sample contains low nitrate level. In this method is based on back estimation as follow:

Length wave of spectrophotometer was set to 220 nm and absorption was measured due to presence of organic matter and nitrate ion. The same measurement was made at wave length 270 nm which resulted in to the measurement of absorption only due to organic matter and not because of nitrate ions therefore, by taking difference of these two results gives the absorption due to nitrate ions is obtained.

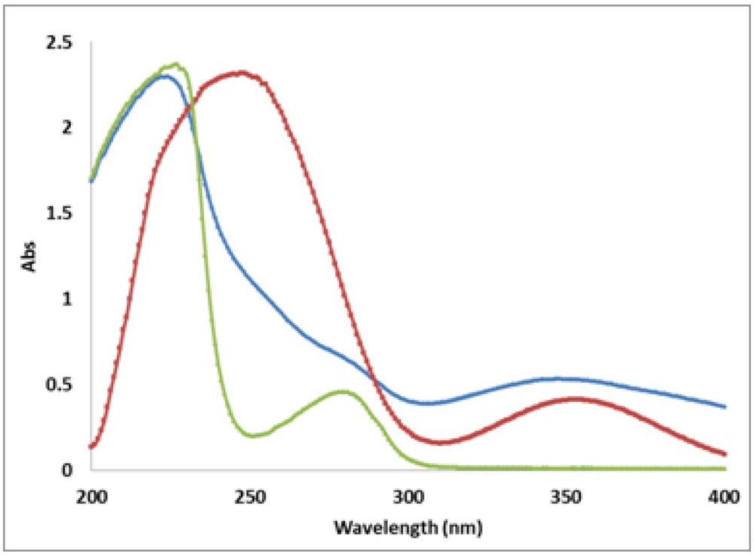


Fig. 3.7

Sample absorption curve for Nitrate determination.

Reagents: -

Double distilled water without having nitrate ions.

Stock nitrate solution: 0.7218 g anhy potassium nitrate was dissolved in deionized water and the total volume was made to 100 mL.

Hydrochloric acid: 1N HCl.

Procedure:

Standard curve preparation*:* Series of solutions of nitrate ions with concentration in the range of 0-0.35 µg/ mL. were prepared Also mL HCl was added to each solution.

Sample preparation: 50 mL water sample was taken and 1mL HCl was added to it.

Measurement of Absorption: - First reference solution was taken in the photometric cell and the absorption (O.D.) was measured at wave length 220 nm for absorption due to nitrate plus organic matter and at 270 nm for absorption due to organic matter only. Nitrate ions concentration was obtained by subtracting absorption at wave length 220 nm from the absorption at wave length 270 nm. Data obtained plotted as absorption vs concentration of nitrate ions straight line was obtained corresponding to water sample's absorption and it was extra plotted on x-axis to get concentration of nitrate ion present in the water sample.

Determination of Fluoride ion by spectrophotometric method

Principle: - **F^-** is generally very common in all water samples, but when it is present in but lower than this limit may causes dental problem such as dental caries but higher level (greater than 4 mg/L) result in to the fluorosis disease. This disease is very common in the various parts of India in which fluoride level is more than 10 mg/L.

Fluoride detection is done by decreasing in color intensity of zirconium ion resultant to colorless complex formation. (Absorbance was measured at 570 nm)

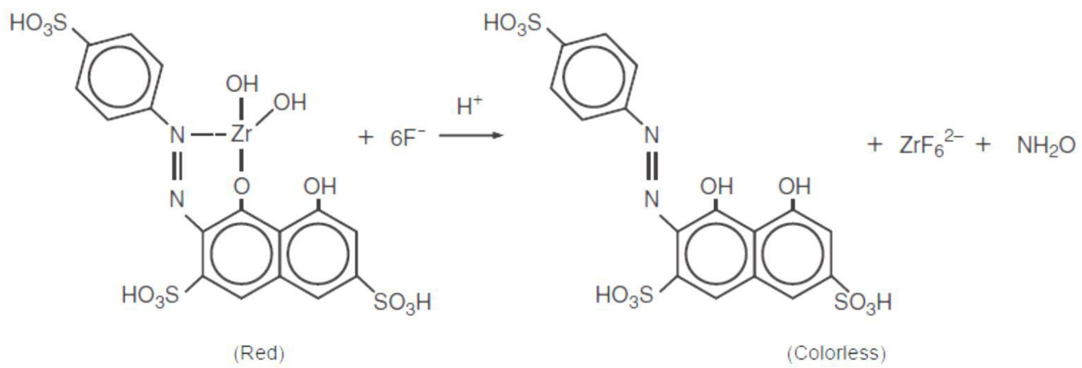


Fig. 3.8 Reaction between fluoride ion

Reagents: -

Water: Deionized double distilled water.

Standard solution preparation: - 0.221g Sodium fluoride dissolved in 1 Liter of water and then again diluted by facing 100 mL of this solution water 1 Liter using water called 0.01 mg/L.

SPADNS solution: - 0.960g SPADNS taken in 500 mL water.

Reference cell solution: Take 10 mL of SPADNS solution in to 100 mL of water and 10 mL of Conc HCl solution.

SPADNS mixed reagent: 0.135 g $ZrCl_4$ $8H_2O$ was added to 350 mL conc HCl and diluted this solution to 500 mL using distilled water.

Process: Various standard solution was made by taking 0, 2, 4, 6, 8, 12 and 14 mL stock solution in to 100 mL volumetric flask and was made to 100 mL using distilled water.

Then, 50 mL of each solution was taken in separate flask and 10 mL SPADNS was added reagent to each flask so the concentration of fluoride ion become 0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2 and 1.4 µg/mL kept the solution was for 30 minutes at equal temperature.

Determination of Total Alkalinity by Titrimetric Method

It is an important parameter which control potable and waste water. Alkalinity of water is due to presence of bicarbonate, hydroxide, carbonates, phosphate etc.

Principle: Alkalinity is measured for the neutralizing reaction with strong acid of known volume and concentration. Titration will give result of consumption of sulphuric acid and on the basis of that alkalinity is calculated.

Titration of samples were performed at acidic pH say 4.5 where indicator phenolphthalein remains colorless and then after adding base indicator gives pink color at pH of alkali range of 8.3.

Reagents:

Water: Deionized double distilled water, 0.02N sulphuric acid was used

Phenolphthalein Indicator: 1 percent phenolphthalein in alcohol was used as the indicator.

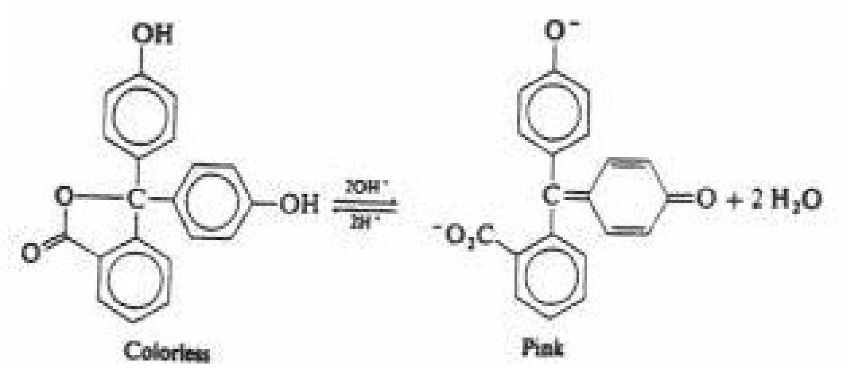
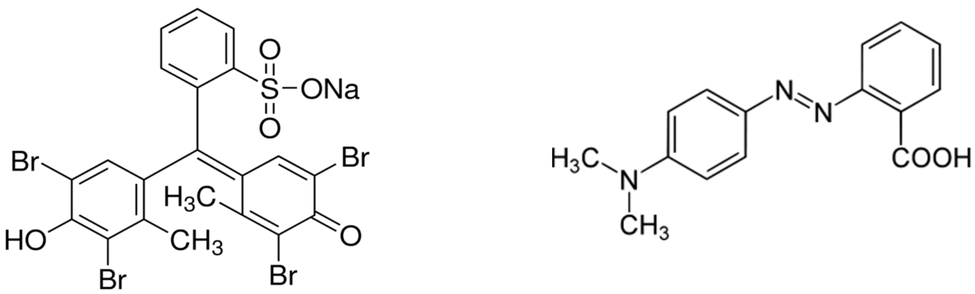


Fig. 3.10

Mix Indicator: 0.02 g methyl red and 0.1 g bromocresol green were taken in 100 mL alcohol (95 %) and was kept in air tight container as the alcohol is volatile.



Bromocresol green **Methyl Red**

Fig. 3.11

Process: -

100 mL water sample in to conical flask, add 2-3 drops of phenolphthalein indicator was added to it and titrate entire solution against 0.02 N H_2SO_4 solution at the end point color change from pink to colorless, (called **Va** mL).

Fig. 3.12

In above same flask 2 drops of mixed indicator was added to mixture and titrated it against 0.02 N till the color change was observed from blue to red. Final end point reading called **Vb** mL.

Fig. 3.12

Calculation: Total Hardness

$$N_1V_1=N_2V_2$$

Alkalinity due to hydroxide ion, Where

N_1= Normality of H_2SO_4

V_1= Volume of H_2SO_4 consumed (called V_a mL) N_2= Normality of hydroxide ion in water sample, V_2= Volume of water sample

Alkalinity due to other ions ion, Where: -

N_1= Normality of H_2SO_4

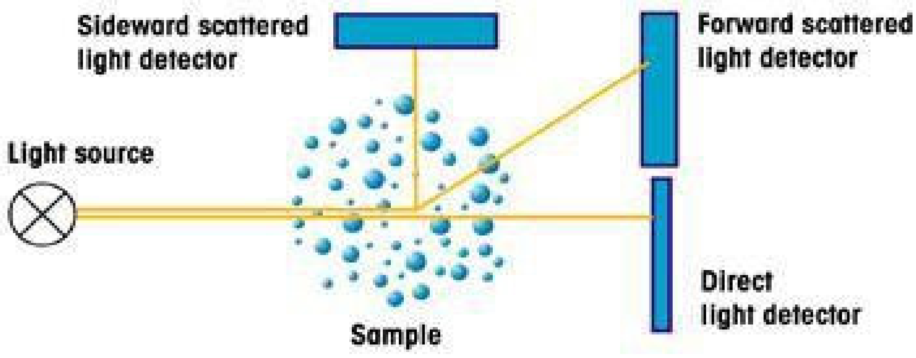
V_1= Volume of H_2SO_4 consumed (called V_b mL)

N_2= Normality of carbonate/bicarbonate ions in water sample V_2= Volume of water sample

Results from above data is multiplied with their molecular weight. For hydroxide multiplied with 40 mol. Wt. of NaOH and for carbonate and bicarbonate multiplied with 100. As a result, alkalinity comes in mg/L. By addition of both, is obtained total alkalinity.

Turbidity determination by Turbidity meter

Principle: Measurement of clarity of water sample is not directly possible but it is possible by measurement of transparency in the medium. Number of methods are available for determination of turbidity but one of the important methods is using turbidity meter. Turbidity is due to suspended organic and inorganic waste present in water sample.



$$\text{Turbidity } 25^\circ \sim \frac{\text{Forward scattered light}}{\text{Direct light}} \qquad \text{Turbidity } 90^\circ \sim \frac{90^\circ \text{ Scattered light}}{\text{Direct light}}$$

Turbidity measured at 90° is called NTU

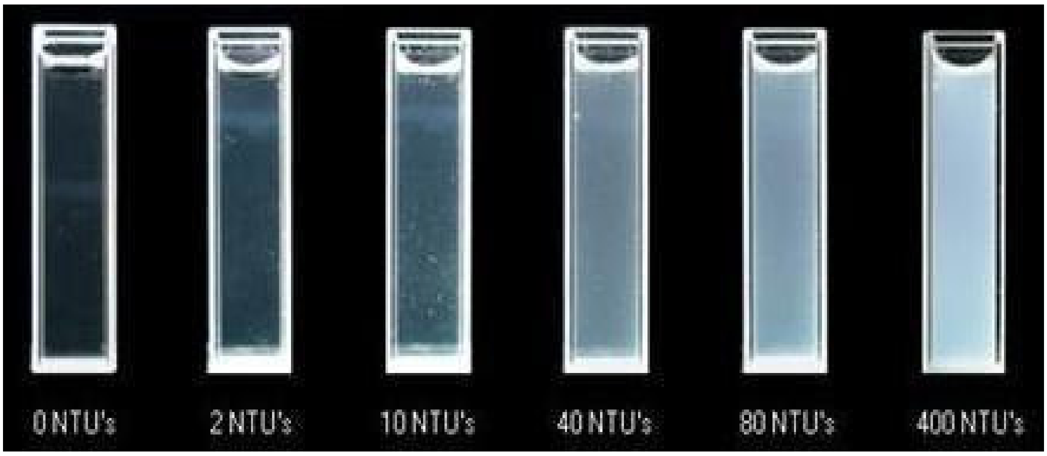


Fig. 3.13

Process:

Turbidity meter is calibrated with standard solution of 0.02 N NTU. Here, NTU stands for Nephelomatric Turbid is unit, which is a measure of turbid is in water samples is due to suspended solids. The relation between suspended solid and NTU is mg L^{-1} suspended solid equipment to 3NTU according to Who Standard the turbitidity of drinking water must be less then 5NTU

Before measurement of turbidity, it is necessary that water attains at room temperature because, at lower temperature, turbidity increases.

Sample was inserted in the cuvette, it was allowed to get rid of air bubbles obtained during sample procedure. Then it was mixed to make homogeneous by micropipette.

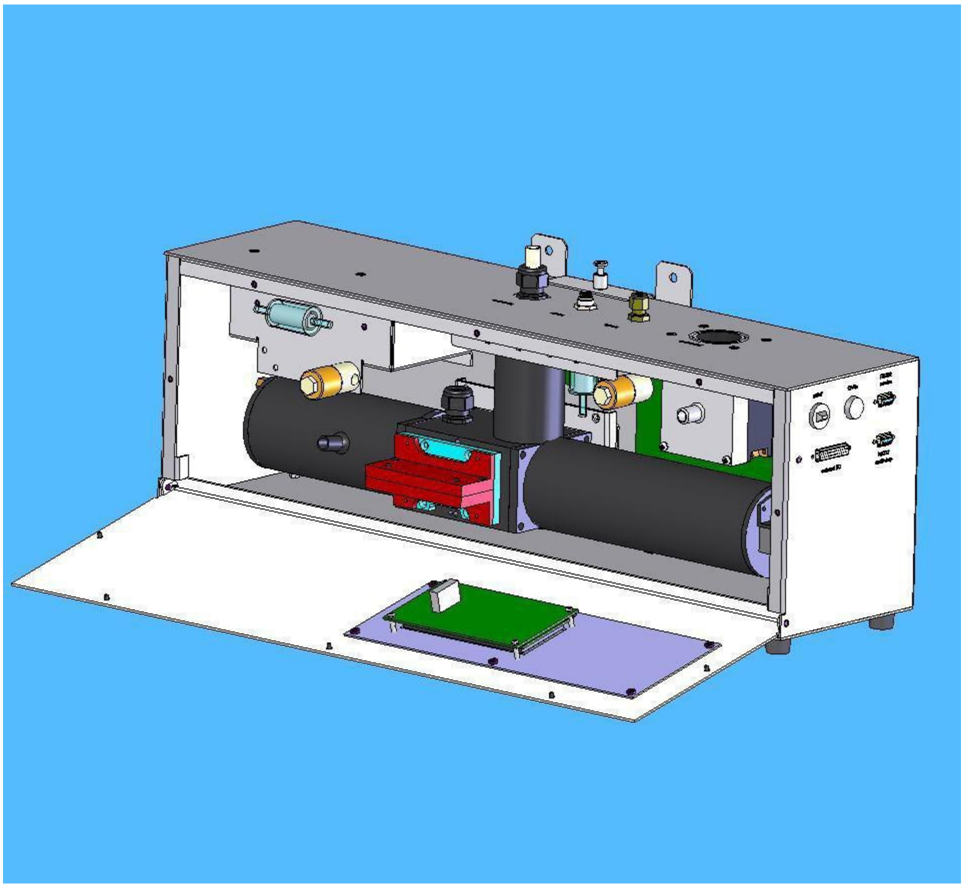


Fig. 3.14

After all this completed, outer surface was cleaned with the filter paper and turbidity measurement was made. Three consecutive readings were taken and the average value was obtained.

Determination of dissolve oxygen by titrimetric methods

Principle: - Oxygen atom is present in the formula of water.in pure water, more oxygen gets dissolved in it. This is possible by removing carbon dioxide and hydrogen sulphide gas. We know that anything present in excess is poisonous, water with high concentration of dissolved oxygen cannot be used as the coolant in industry, because of its corrosion property. For titrimetric analysis, iodometric method is used.

Reagents: -

Manganese sulphate solution: -

64 g Manganese sulphate was dissolved in water and the solution was made to 1000 mL using distilled water.

Potassium iodide and Alkali solution: - 150 g KI, 700 g KOH and 3 g NaN_3 was taken in 300 mL water and uniformLy mixed well and kept in cooled place under closed vessels.

Sulfuric acid (3:1): Take 750 mL H_2SO_4 and 250 mL distilled water were taken and followed by cooling the solution at room temperature and diluted it to 1000 mL using distilled water.

Sodium Thiosulfate Standard Solution (0.01N): Standard solution of sodium thiosulphate was prepared by dissolving the 25 g of it in 1 liter of water. Standardization of this solution was done using known method.

Starch Solution (Indicator): 2% starch solution was prepared by taking 2 g starch in 100 mL water by heating it and allow to cool at room temperature.

Process:

A long tube, which is longer than BOD bottle (300 mL), was taken and this tube was placed in the sample bottle at one end and the other end was connected with sample filled and is was cap red such that there is no air bubbles left. Now 2 mL alkali solution and 2 mL manganese sulphate solution were added so that tip touches the surface of the solution without removing any air bubbles. The cap was replace again and content was mixed and kept stand still the precipitates settle down so that 2 mL 3:1 solution of sulphuric acid can be added without removing ppts. Same procedure was applied for KI and manganese sulphate. Reaction bottle is heated for agitation of ppts. Reaction time for entire procedure is 15 minutes. Now from this solution, 200 mL was taken and titrated against 0.01N sodium thiosulphate solution which change in the color to blue at the end point.

Calculation:

$$\text{Dissolve Oxygen (mg/L)} = \frac{A \times N \times 8000}{B}$$

Where,

A = burette reading

N = 0.01 i.e. normality of sodium thiosulphate, B = volume of sample taken in mL

Calculation for 200 mL sample taken from 300 mL is as follow:

$$B = \frac{200 \times 300}{300 - Y}$$

Where, y = 4 (i.e. 2mL alkaline KI and 2 mL 3:1 H_2SO_4)

Determination of Chemical oxygen demand (COD)

Principle:-

Chemical oxygen demand is the amount of oxigin required to oxidize the organic matter present in water and it is specific oxidizing agent present in water and the amount of it needed from outside for the experimental conditions. There are number of methods available for determination of COD, but open reflux method is widely used in industry, where large quantity of sample needed. (COD Value 50 mg/mL). Determination of COD given quintively, the pollution leaved of water due to organies. Higher value of COD indicates more pollution of organic matter in water.

Fig. 3.15

Reagents: -

Standard $K_2Cr_2O_7$ Solution: Dissolve 12.25 g potassium dichromate was dissolved in to distilled water and was made to 1liter Results 0.25N solution.

Sulphuric Acid: Conc H_2SO_4 was used

Ferrous ammonium sulphate (FAS):- 39 g FAS was added to 20 mL conc H_2SO_4 to prepare slurry and diluted to 500 mL distilled water to make clear solution followed by further dilution to 1 liter using distilled water.

Ferroin Indicator: This indicator was prepared by taking 0.695 g ferrous sulphate hepta hydrate and 1.485 g phenonthroline monohydrate in 100 mL water.

Mercuric Sulfate: solid form $HgSO_4$ was used

Process:

Fig. 3.16

20 mL water sample was taken in 250 mL RBF fitted with refluxed condenser, 10 mL of prepared 0.25N potassium dichromate and 30 mL conc sulphuric acid were added and allowed to stand after each addition. 400 m mercuric sulphate was added to it and refluxed for 2 hr and the condenser was washed with distilled water. The entire mass was transferred in to 250 mL conical flask and diluted to 150 mL followed by titration of it against FAS solution (taken in burette) using ferrocin as the indicator. At the end point, color change from blues green to reddish brown. In the same way, the blank titration was performed without taking sample. COD was calculated as:

$$\text{COD (mg/L)} = \frac{\text{(Sample-Blank reading)} \times \text{Normality of FAS} \times 8000}{\text{Volume of sample taken}}$$

Determination of Biological Oxygen Demand (BOD)

BOD is nothing but it is the quantity of dissolved oxygen required by aerobic biological organism to dissociate organics present in water sample at definite temperature for a fixed duration of time. And saw it is the concentration of oxygen supplied by microorganism. Aerobic bacteria use organic matter as their food. BOD value are effective parameter to know the pollution leaved and hence quiets of water. It is used as the index for was the water treatment plants. COD and BOD both are indication of organic pollution in water, but COD is less specific were BOD is high, DO value is less and the organism which required more DO, cannot survive.

Principle: -

To evaluate burden on the efficient treatment plants (ETP plant), principle involve is that the back fall process may involve 5 days' time period, as a result, content which was use the oxygen called total biological oxygen demand. BOD5 term used for 5 days which is the time period required for the entire process. Treatment of plants are available in determination of uses of areal oxygen. Such type of organisms use areal oxygen. In the digestion process, the nitrogen compound is converted in to ammonia and CO_2.

Reagents: -

Phosphate buffer: 8.5 g KH_2PO_4 + 21.75 g K_2HPO_4, 1.7 g NH_4Cl 33.4 g, $Na_2HPO_4 \bullet 7H_2O$, were melt in 500 mL grade substance and diluted to 1000 mL by reagent score water. pH of solution was kept 7.2 & stored at lower temperature below 3 degrees Celsius.

Magnesium sulfate solution: 22.5 g $MgSO_4 \bullet 7H_20$ was dissolved in minimum amount of distilled water and then diluted 1 liter using same.

C***alcium chloride solution:*** 27.5 g $CaCl_2$ was dissolved in minimum reagent and diluted to 1 liter using distilled with water.

Ferric Chloride solution: 0.25 g Ferric chloride was dissolved in minimum amount of reagent and diluted to 1 liter using distilled water.

Fig. 3.17

Process:

The pH of sample solution of water sample was kept from 6.5 to 7.5 and it was taken for determination of BOD. If pH value is not in specified required range, then one can set it using 1N H_2SO_4 or 1N NaOH. Water sample is diluted to provide measurable BOD range. Deficiency of mineral and change in pH may lower the pH value. Hach BOD nutrient buffer pillows were used for precipitation of all BOD in the experiment specified by American Public health association (APHA) and environment protection agency (EPA). To ensure maximum level of oxygen it can aerate with 2 μm in line filter for 20 minutes.

All bottles were made air tight and no extra water was allowed to come out from bottle by overflow. Poly propylene cap was used for the bottle. Surgical gum was used to remove BOD hooked in thin water.

For barometric pressure checking, the meter calibrated before use for every day analysis. DO was determined for blank solution also. Sample and blank solutions are kept at 20 ± 1°C for 5 days in the incubator. Check the daily added aquatic to closer if required.

Calculations:

$$\text{BOD (mg/L)} = \frac{(\text{Initial DO} - DO_5) \times \text{Dilution factor}}{\frac{(\text{Bottle volume 300mL})}{\text{Sample Volume}}}$$

Dilution factor = Dilution factor is the ration of the volume of diluted sample to volume of the undiluted sample

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CHAPTER – IV

RESULTS AND DISCUSSION

CONTENTS

4.1 PHYSICOCHEMICAL PARAMETERS OF ANKLESHWAR TALUKA

Ground water analysis of water samples collected from 15 stations of ANKLESHWAR TALUKA of BHARUCH DISTRICT such as SARTHAN, TELVA, PILUDRA, UMARWADA, JETALI, PIPROD, AVADAR, PARDI MOKHA, SANGPOR, KOSAMADI, PANOLI, KHAROD, MOTALI, ANDALA AND UTIYADARA.

All parameters are measure in terms of pH, Fluoride, Nitrate, Hardness, Akalinity, Phosphate, Ca^{2+}, Mg^{2+}, Sulphate ion, COD, BOD. TDS and Total dissolved oxygen etc. All parameters are measured in winter, summer and monsoon seasons.

Table 4.1: Physicochemical Parameter of Ground Water from Ankleshwar Taluka of Bharuch District, Gujarat (Winter)

Physicochemical parameters															
Sr. No.	Station Name	TDS mg/ L	pH	Total Hardness mg/L	Ca^{2+} mg/ L	Mg^{2+} mg/ L	Cl^{1-} mg/ L	SO_4^{2-} mg/ L	NO_3^- mg/L	F^{1-} mg/ ssL	ALKALINITY mg/L	TURBIDITY NTU	COD mg/ L	BOD mg/ L	DO mg/L
1	SARTHAN	486	6.91	378	38	33	75	40	15.80	0.1	422	3.4	15	8	0.58
2	TELVA	504	6.99	380	36	32	80	41	15.36	0.4	410	3.8	16	7	0.89
3	PILUDRA	448	7.03	360	35	33	88	45	10.22	0.3	316	2.8	13	8	0.85
4	UMARWADA	594	7.00	365	34	32	108	38	13.14	0.6	368	2.9	12	6	0.86
5	JETALI	744	6.82	390	38	31	85	36	16.20	0.5	365	3.8	11	9	0.75
6	PIPROD	628	6.85	385	39	31	110	34	16.18	0.2	420	2.5	14	8	0.90
7	AVADAR	510	6.92	375	37	32	95	45	19.10	0.3	432	2.4	13	8	10.2
9	SANGPOR	535	7.01	380	38	31	80	52	18.21	0.3	318	3.9	15	7	0.75

10	KOSAMADI	485	6.83	375	35	46	72	35	15.82	0.2	314	3.3	11	6	0.73
11	PANOLI	636	7.60	257	60	23	98	40	8.52	0.2	310	3.8	14	2	0.32
12	KHAROD	742	7.70	265	39	54	120	38	8.11	1.2	435	2.6	15	3	0.75
13	MOTALI	545	7.10	300	38	32	88	42	10.12	0.3	321	3.8	15	4	0.65
14	ANDALA	515	7.42	302	38	38	38	35	12.12	0.4	290	1.4	10	7	0.89
15	UTIYADARA	580	7.10	280	41	40	95	42	17.35	1.1	293	2.6	11	4	0.60

Table 4.2: Physicochemical Parameter of Ground Water from Ankleshwar Taluka of Bharuch District, Gujarat (Summer)

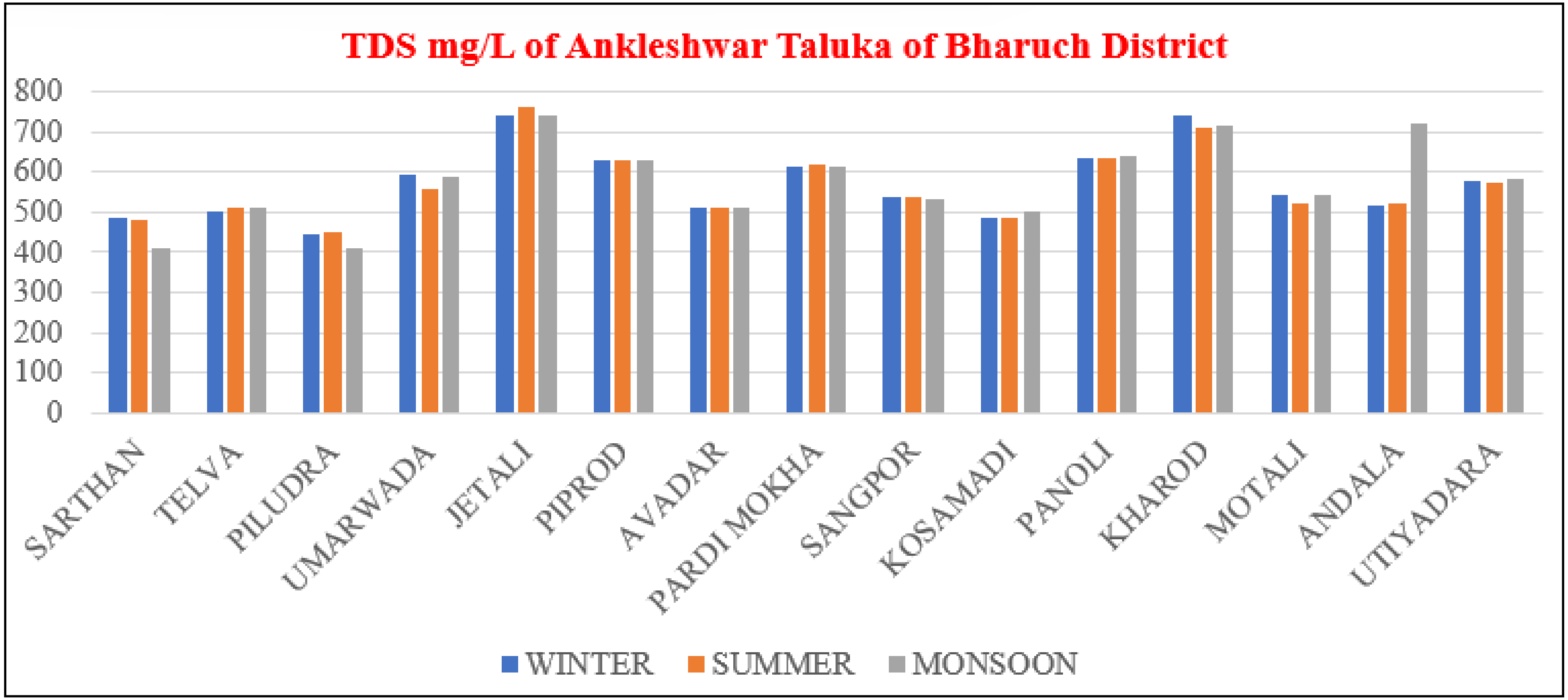
Physicochemical parameters															
Sr. No.	**Station Name**	**TDSmg /L**	**pH**	**Total Hardness mg/L**	**Ca^{2+} mg/L**	**Mg^{2+} mg/L**	**Cl^{1-} mg/L**	**SO_4^{2-} mg/L**	**NO_3^{1-} mg/L**	**F^{1-} mg/L**	**ALKALINITY mg/L**	**TURBIDITY NTU**	**COD mg/L**	**BOD mg/L**	**DO mg/L**
1	SARTHAN	481	6.82	380	39	32	71	42	14.80	0.2	430	3.5	14	9	0.60
2	TELVA	510	6.72	385	38	34	81	42	13.36	0.3	410	3.8	19	8	0.81
3	PILUDRA	452	7.12	365	30	30	82	46	12.22	0.4	320	2.7	14	7	0.82
4	UMARWADA	560	7.10	360	29	35	105	39	13.15	0.7	370	2.6	13	5	0.84
5	JETALI	760	6.56	392	40	30	86	38	16.22	0.6	360	3.9	12	8	0.73
6	PIPROD	630	6.90	380	41	30	112	39	16.19	0.3	422	2.4	14	7	8.2
7	AVADAR	512	7.15	360	42	35	96	46	19.10	0.4	430	2.3	12	7	0.92
9	SANGPOR	540	6.35	372	35	35	82	50	19.21	0.4	314	3.7	18	8	0.73

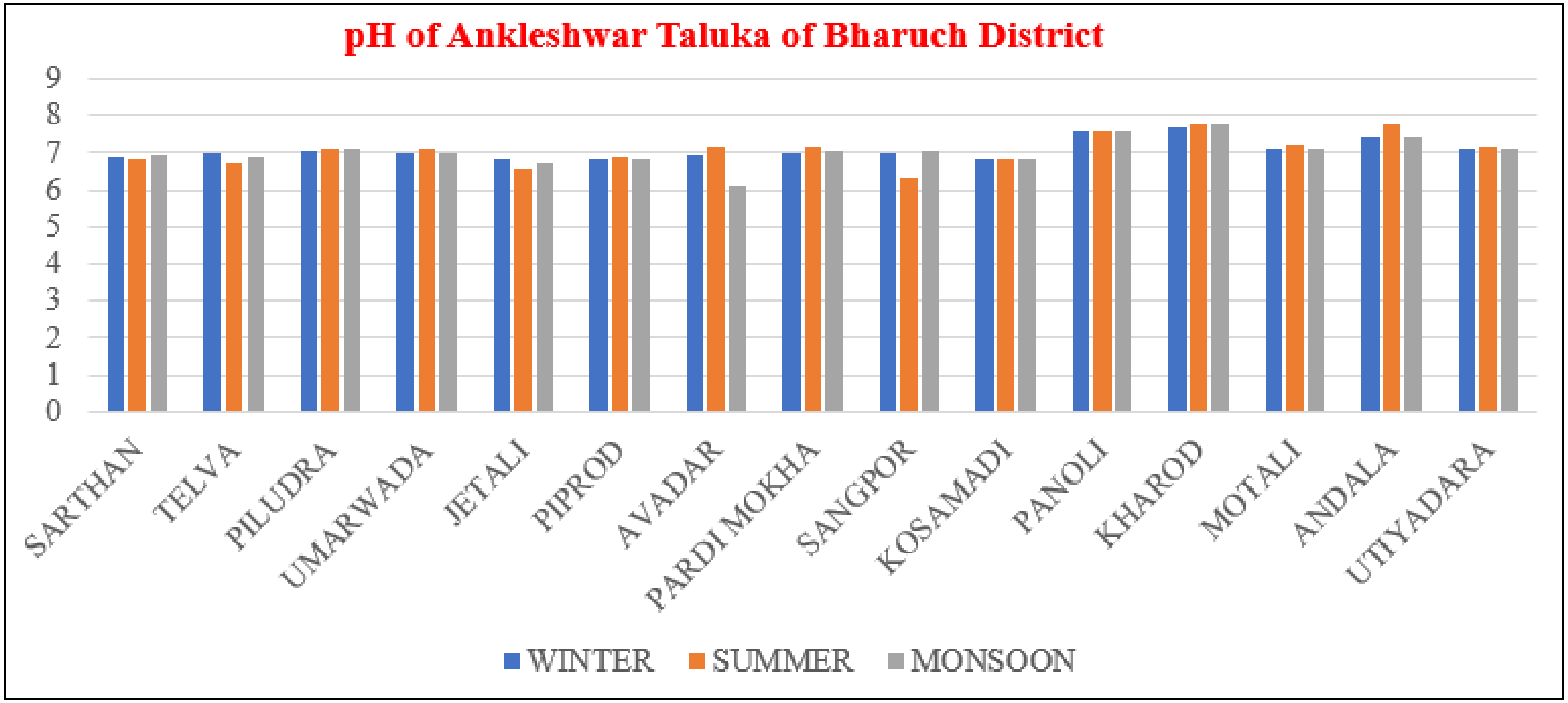
10	KOSAMADI	487	6.81	378	36	48	75	36	15.81	0.3	315	3.2	10	8	0.74
11	PANOLI	635	7.61	258	62	25	95	42	8.50	0.1	312	3.6	12	3	0.38
12	KHAROD	712	7.75	268	37	58	122	39	8.10	1.1	433	2.7	14	4	0.70
13	MOTALI	520	7.20	310	36	32	82	41	10.14	0.5	329	3.8	17	4	0.60
14	ANDALA	520	7.78	319	37	53	40	34	12.10	0.2	298	1.2	11	5	0.84
15	UTIYADARA	575	7.14	290	40	42	92	40	17.30	1.2	294	2.7	12	3	0.62

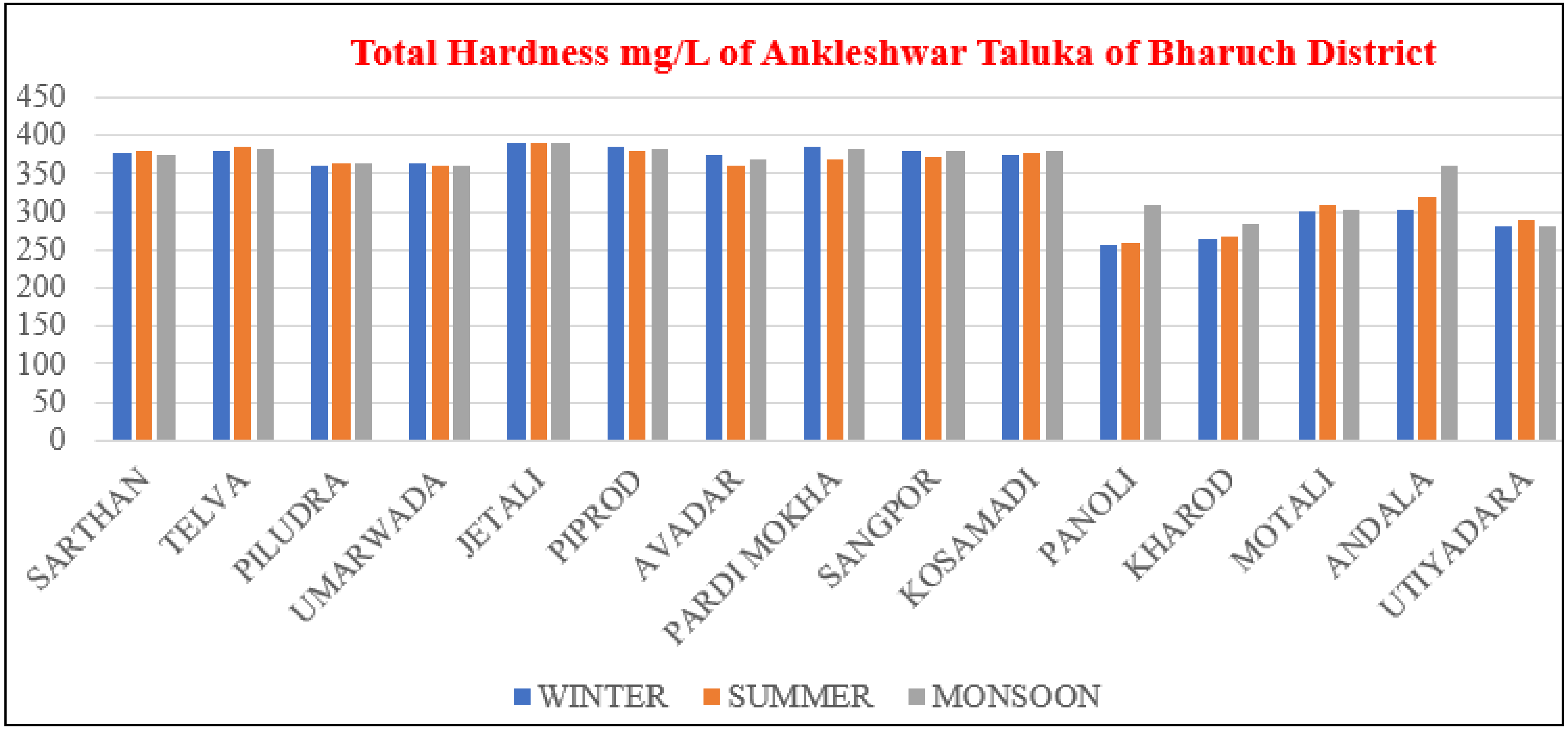
Table 4.3: Physicochemical Parameter of Ground Water from Ankleshwar Taluka of Bharuch District, Gujarat (Monsoon)

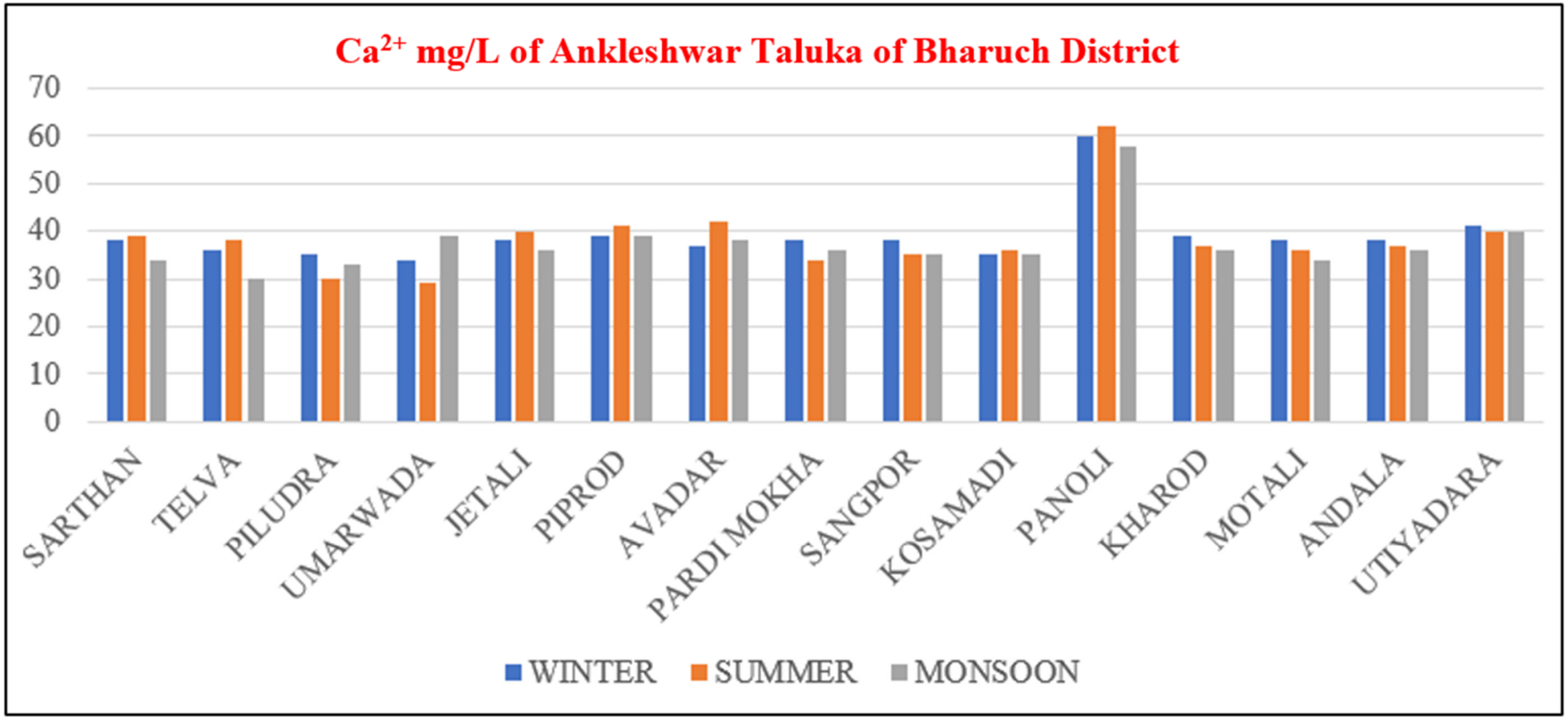
		Physicochemical parameters													
Sr. No.	Station Name	TDS mg/L	pH	Total Hardness mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Cl^{1-} mg/L	SO_4^{2-} mg/L	NO_3^{1-} mg/L	F^{1-} mg/L	ALKALINITY mg/L	TURBIDITY NTU	COD mg/L	BOD mg/L	DO mg/L
1	SARTHAN	408	6.92	375	34	31	74	42	15.82	0.1	420	3.6	12	9	0.60
2	TELVA	510	6.90	382	30	29	54	40	15.20	0.3	418	3.6	15	8	0.85
3	PILUDRA	410	7.10	364	33	30	84	42	10.20	0.4	318	2.8	12	6	0.82
4	UMARWADA	590	7.02	360	39	30	102	36	13.12	0.7	370	2.7	15	7	0.82
5	JETALI	742	6.75	392	36	32	86	38	14.21	0.6	360	3.8	12	6	0.70
6	PIPROD	630	6.82	382	39	30	80	36	16.14	0.3	425	2.5	13	8	8.9
7	AVADAR	512	6.10	370	38	34	99	48	19.12	0.5	430	2.5	13	8	0.90
8	PARDI	612	7.08	382	36	36	78	48	20.20	0.2	320	3.9	16	6	0.85

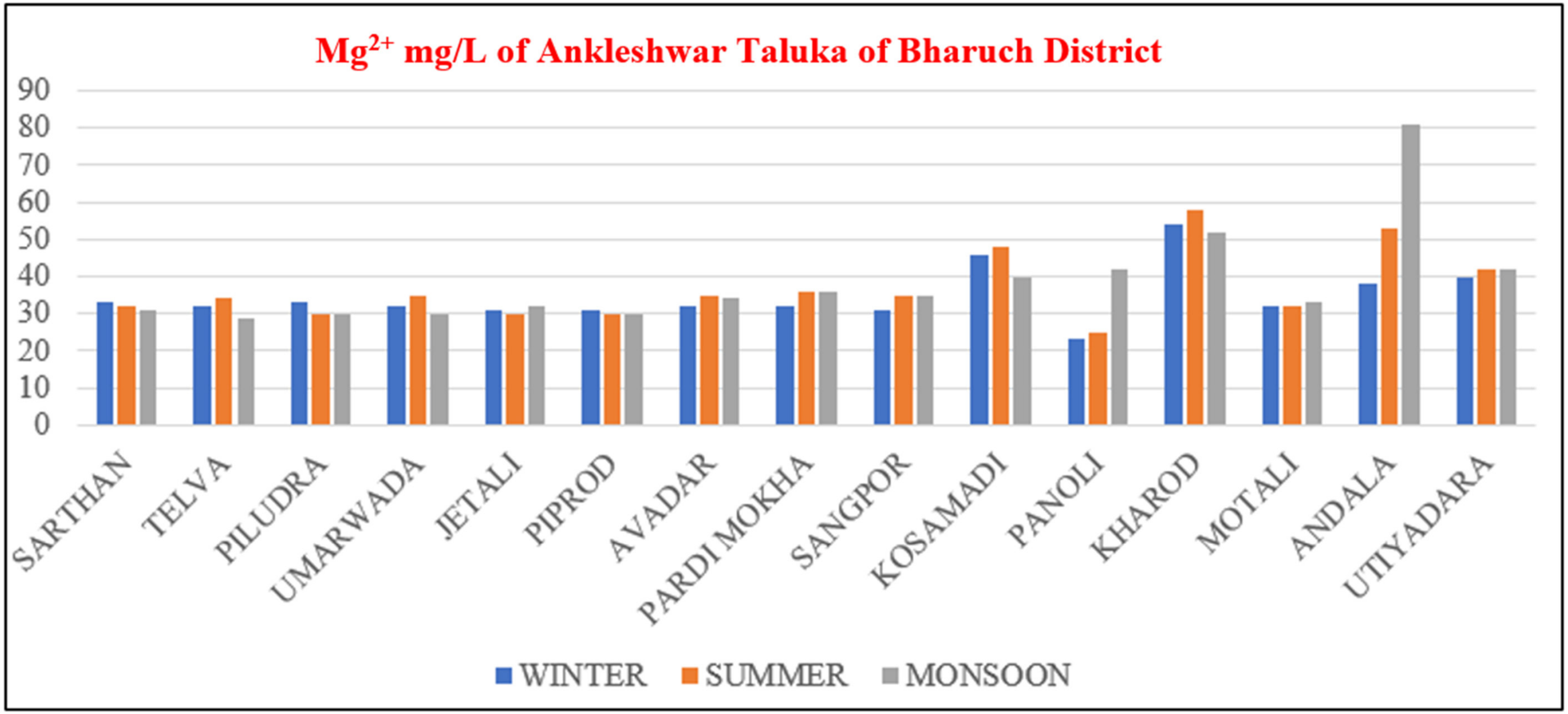
9	SANGPOR	530	7.04	381	35	35	82	53	18.20	0.4	319	3.6	19	6	0.74
10	KOSAMADI	500	6.84	380	35	40	75	37	15.81	0.3	320	3.4	10	5	0.70
11	PANOLI	640	7.62	310	58	42	85	45	8.52	0.6	332	3.7	13	3	0.30
12	KHAROD	715	7.75	283	36	52	109	36	8.12	0.8	395	3.2	14	2	0.71
13	MOTALI	542	7.12	302	34	33	85	40	10.10	0.5	325	3.4	18	6	0.62
14	ANDALA	720	7.44	360	36	81	55	34	12.12	0.6	295	1.6	11	6	0.82
15	UTIYADARA	582	7.12	281	40	42	90	40	17.30	1.2	290	2.2	09	5	0.62

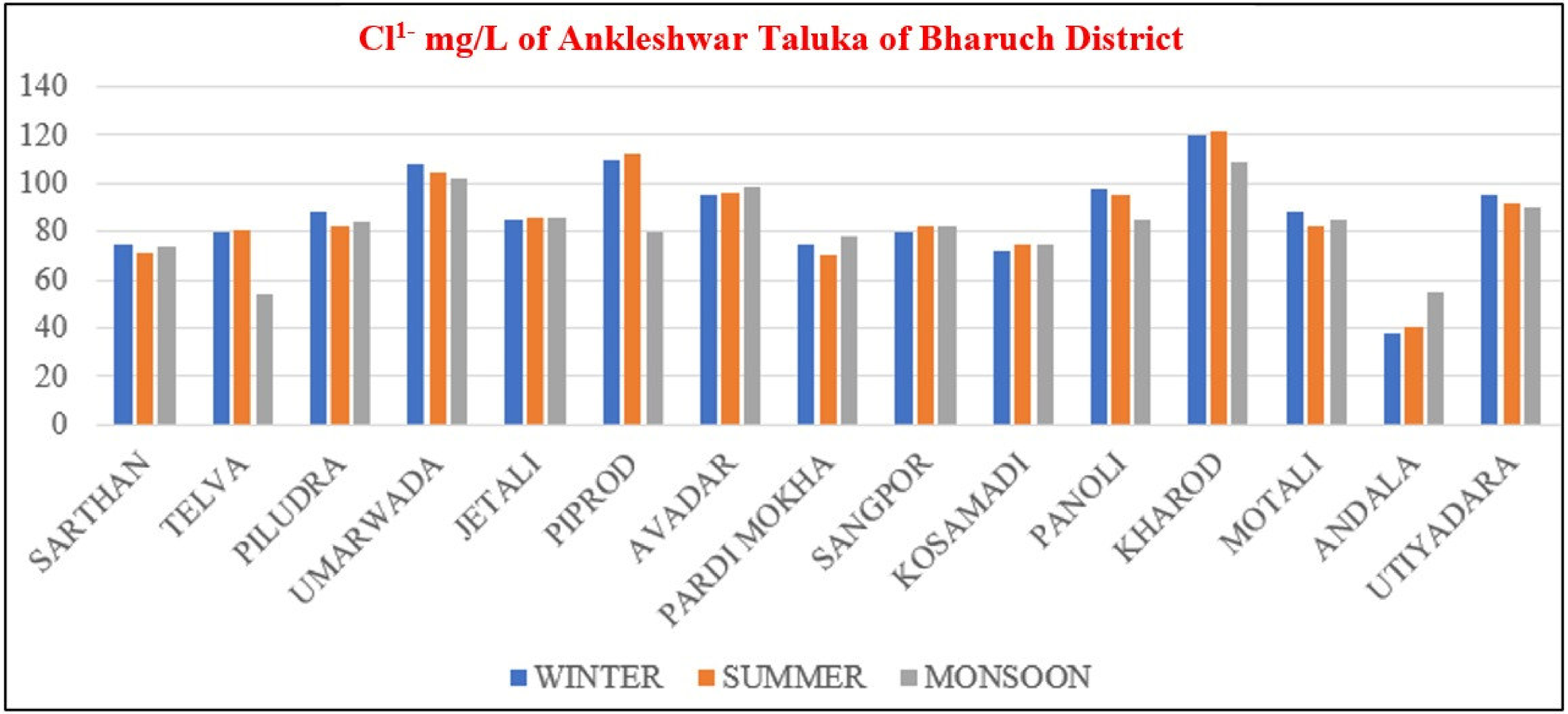

TDS mg/L of Ankleshwar Taluka of Bharuch District
800
700
600
500
400
300
200
100
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON

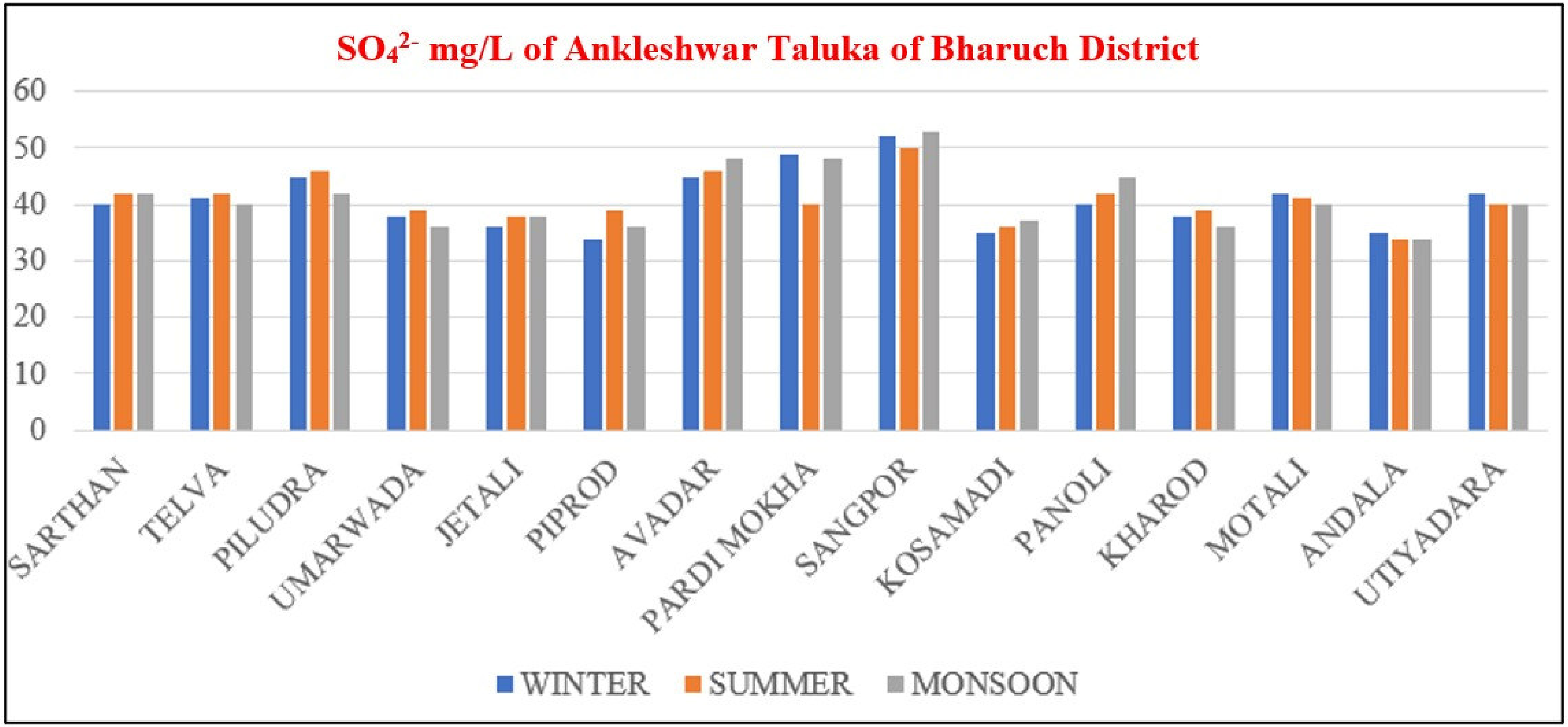

pH of Ankleshwar Taluka of Bharuch District
9
8
7
6
5
4
3
2
1
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON

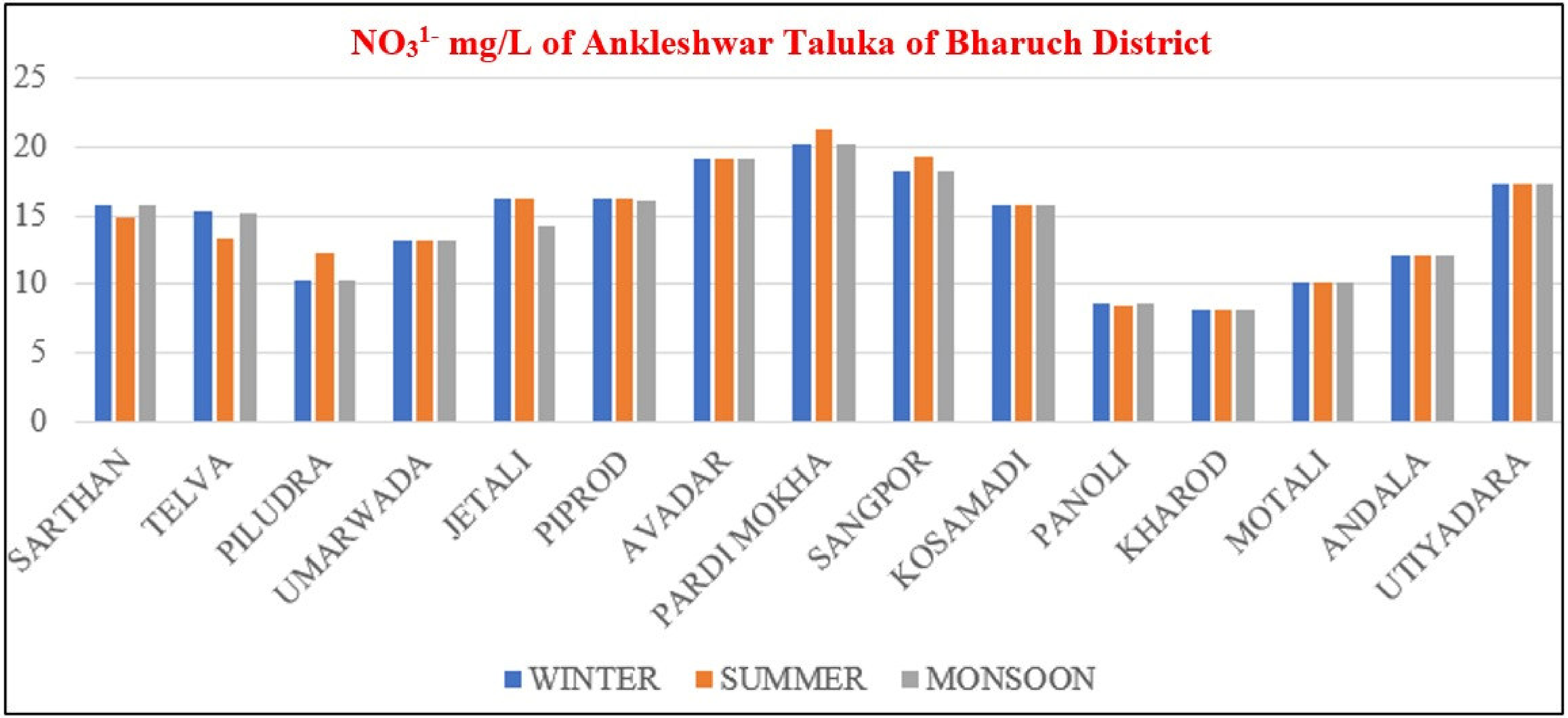

Total Hardness mg/L of Ankleshwar Taluka of Bharuch District
450
400
350
300
250
200
150
100
50
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON

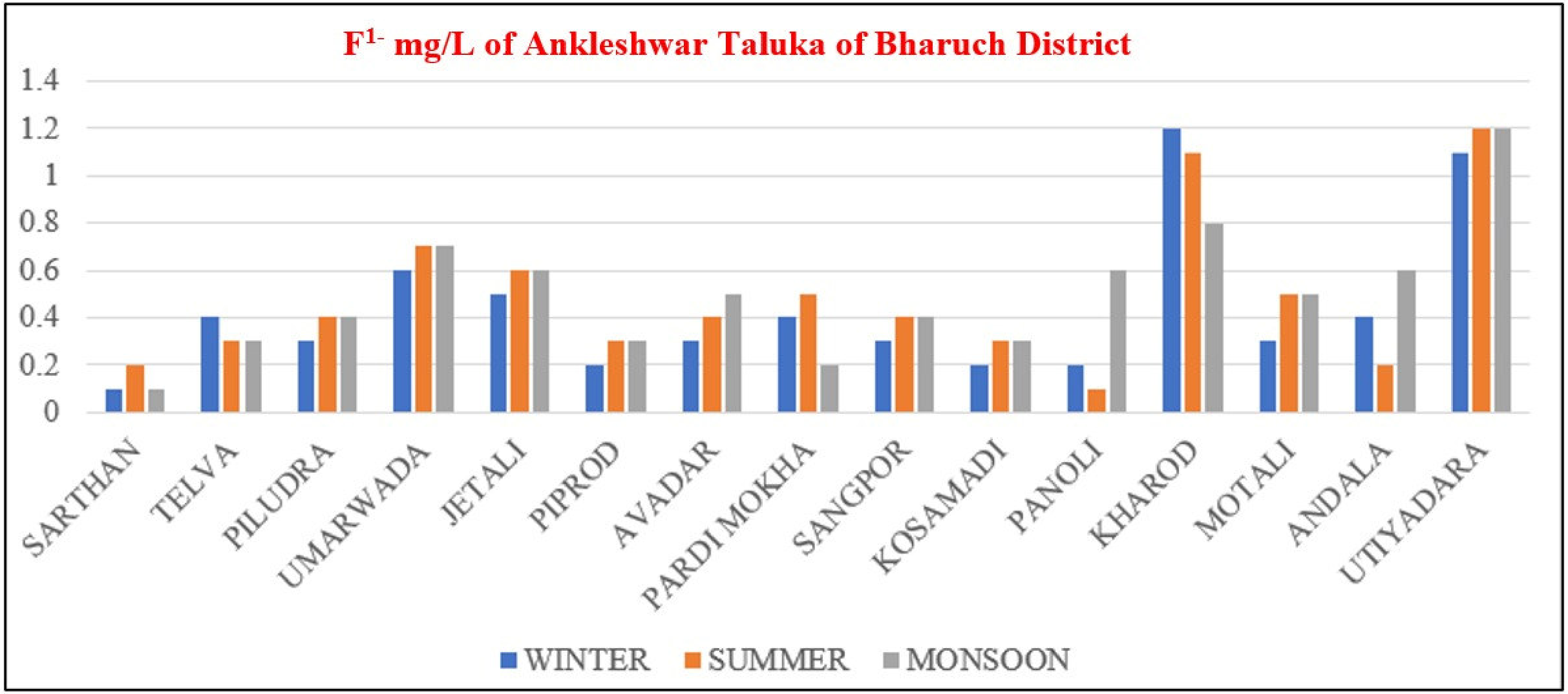

Ca2+ mg/L of Ankleshwar Taluka of Bharuch District
70
60
50
40
30
20
10
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON


Mg2+ mg/L of Ankleshwar Taluka of Bharuch District
90
80
70
60
50
40
30
20
10
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON

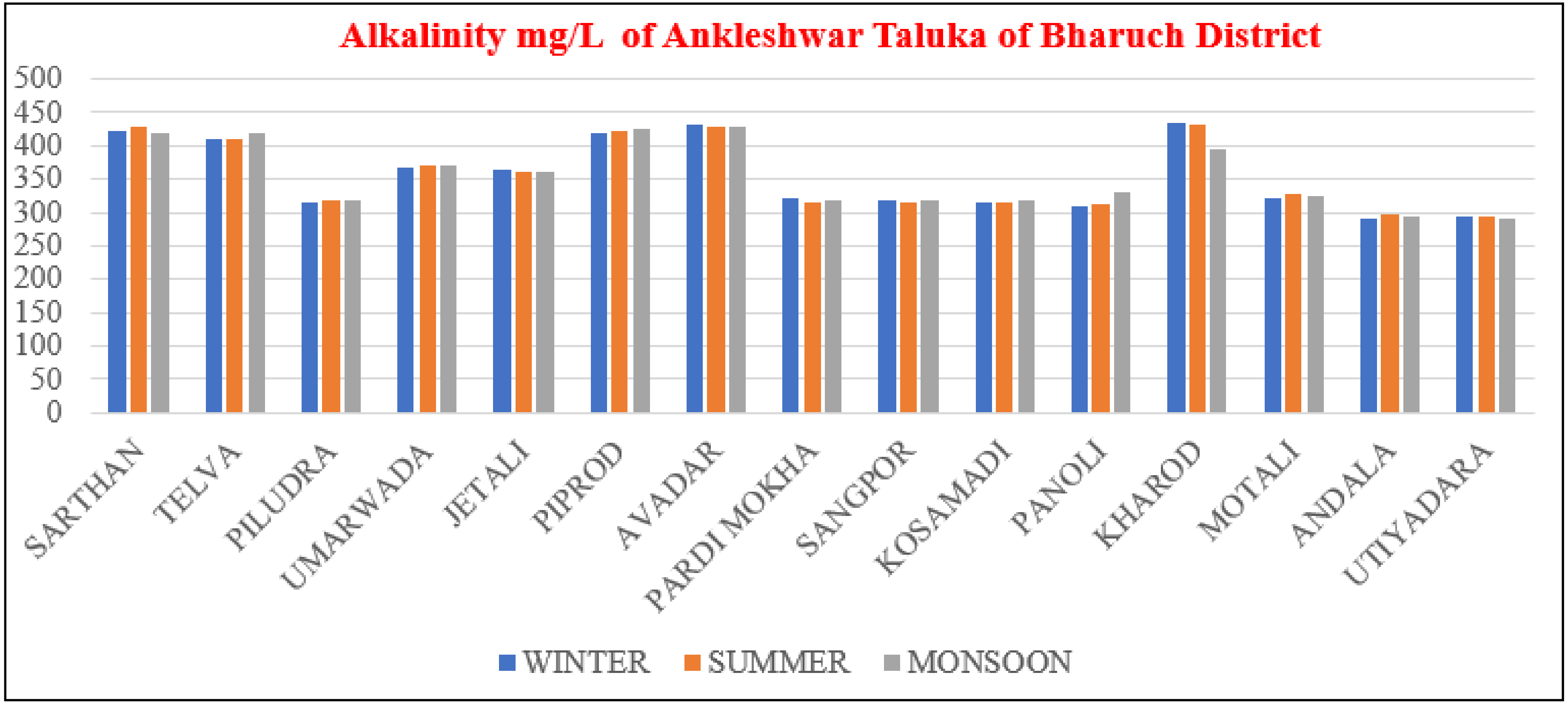

Cl1- mg/L of Ankleshwar Taluka of Bharuch District
140
120
100
80
60
40
20
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON

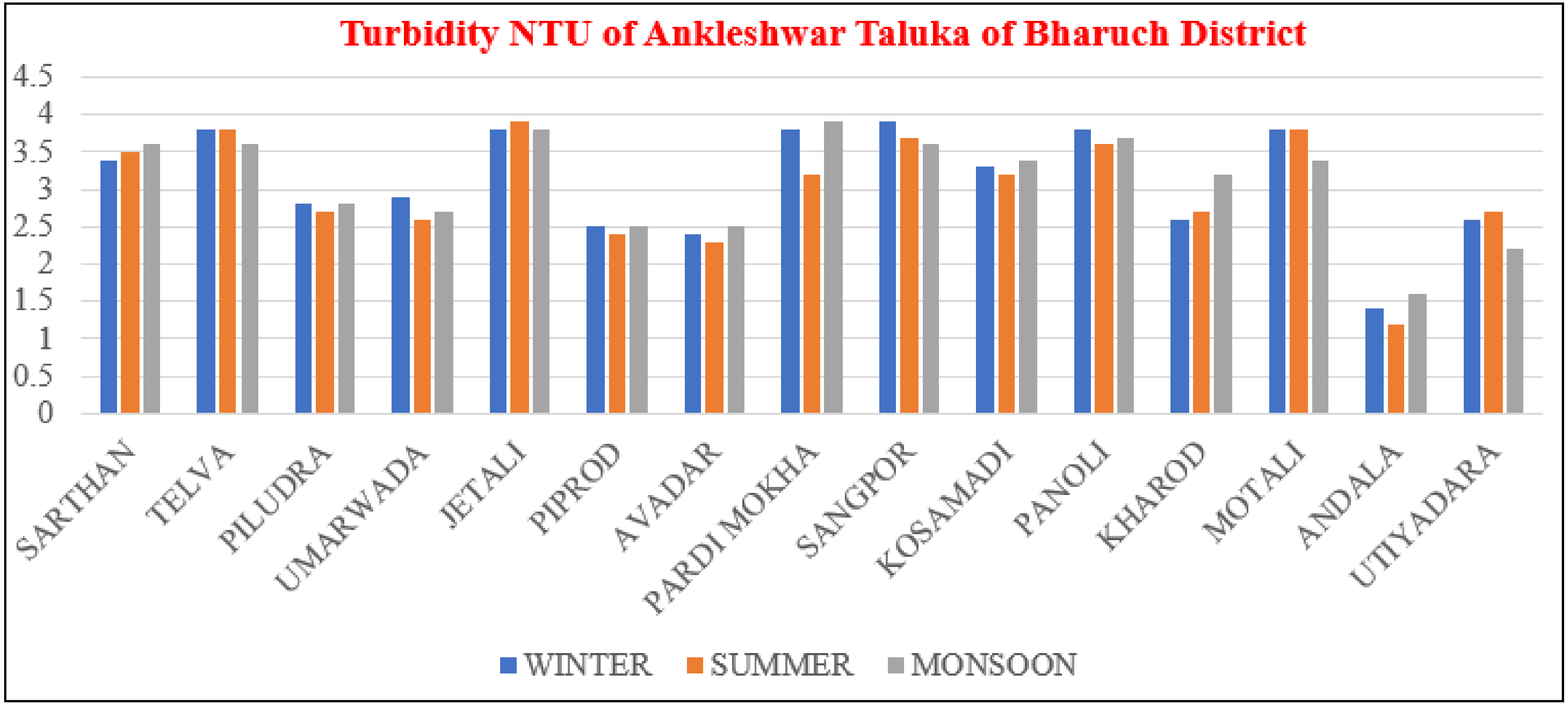

SO4 2- mg/L of Ankleshwar Taluka of Bharuch District
60
50
40
30
20
10
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON


NO3 1- mg/L of Ankleshwar Taluka of Bharuch District
25
20
15
10
5
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON

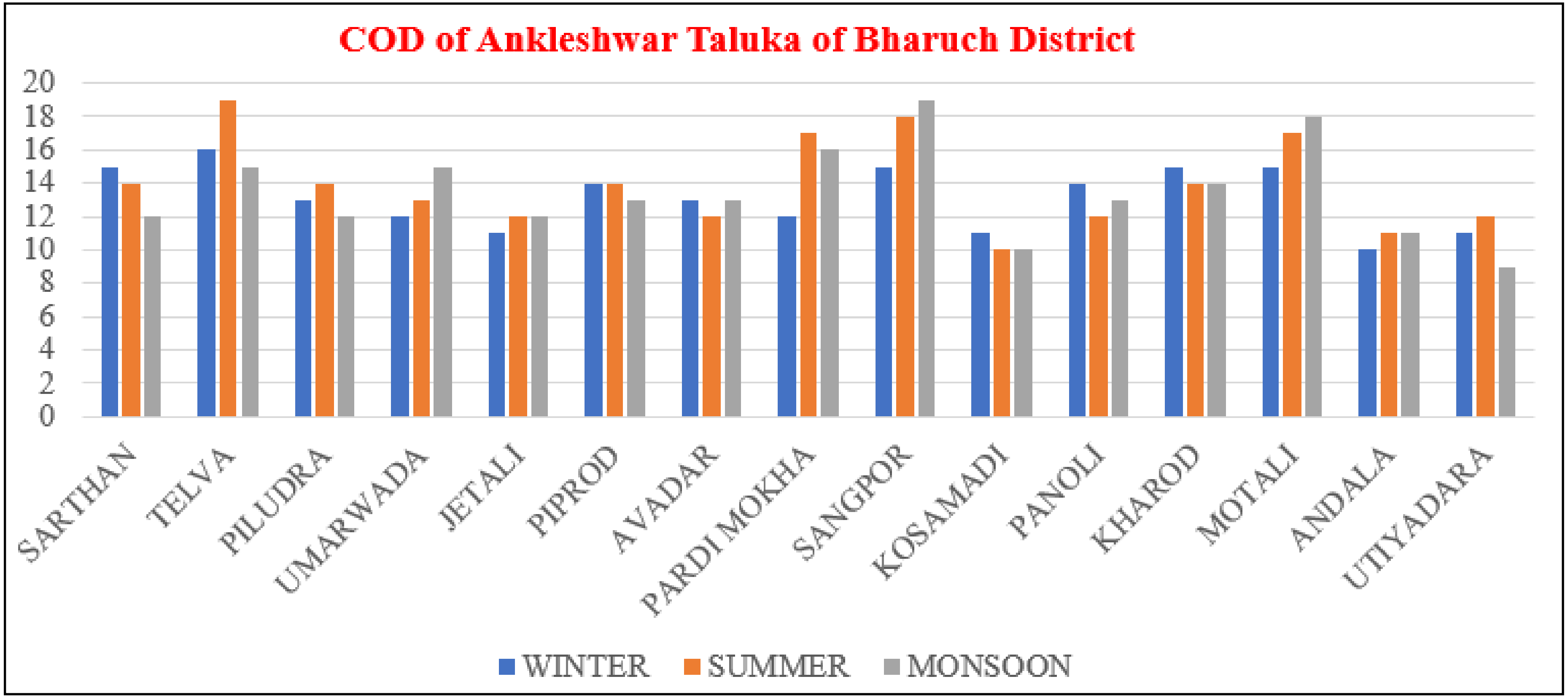


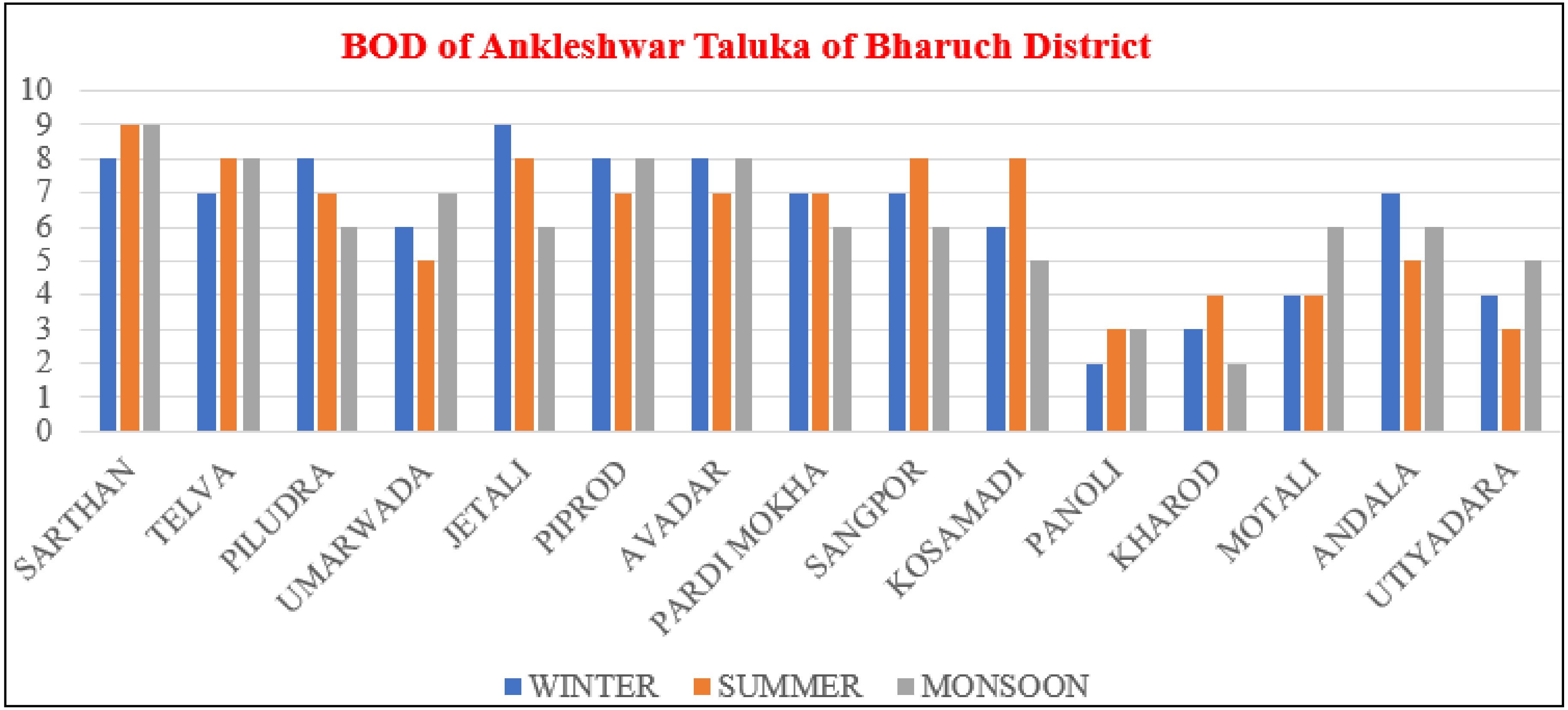
F^{1-} mg/L of Ankleshwar Taluka of Bharuch District
1.4
1.2
1
0.8
0.6
0.4
0.2
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON

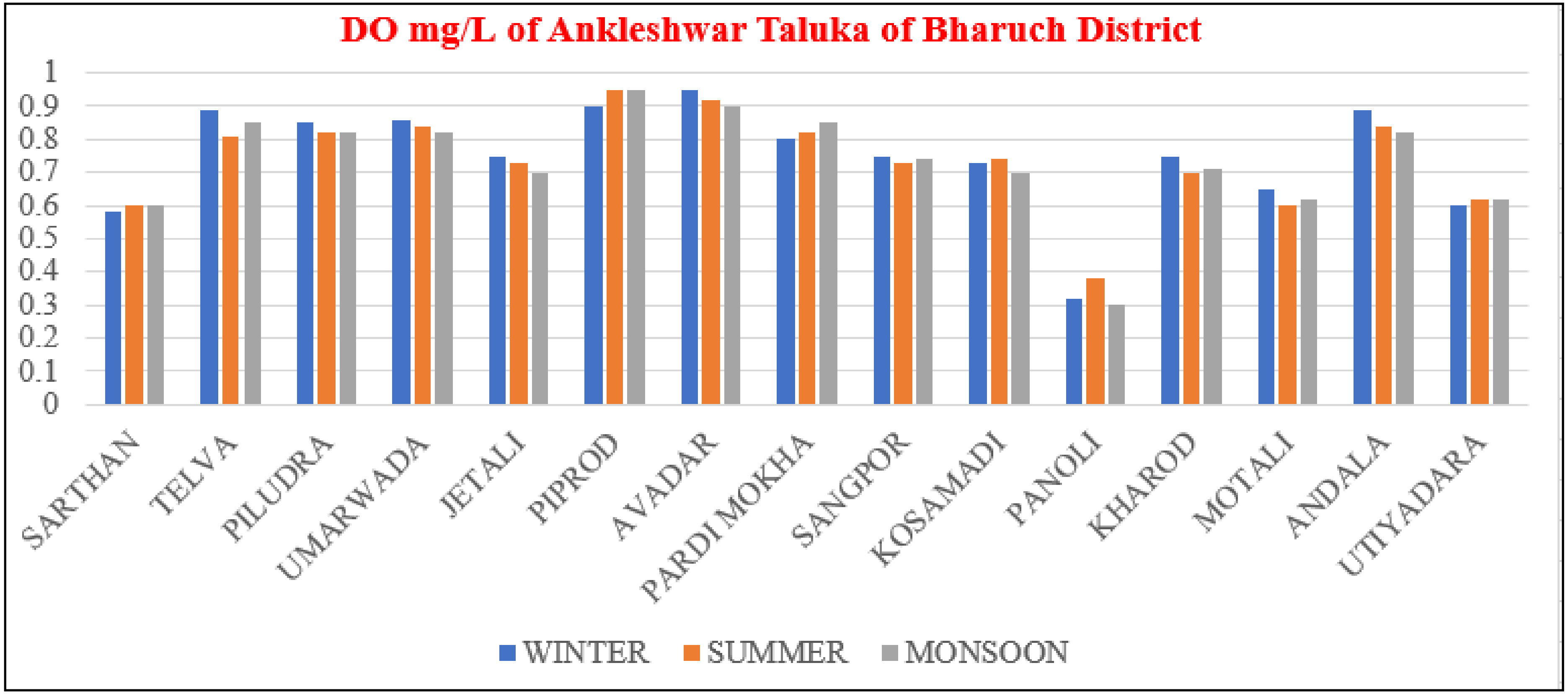

Alkalinity mg/L of Ankleshwar Taluka of Bharuch District
500
450
400
350
300
250
200
150
100
50
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON



Turbidity NTU of Ankleshwar Taluka of Bharuch District
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON


COD of Ankleshwar Taluka of Bharuch District
20
18
16
14
12
10
8
6
4
2
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON


BOD of Ankleshwar Taluka of Bharuch District
0
1
2
3
4
5
6
7
8
9
10
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON


DO mg/L of Ankleshwar Taluka of Bharuch District
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
SARTHAN
TELVA
PILUDRA
UMARWADA
JETALI
PIPROD
AVADAR
PARDI MOKHA
SANGPOR
KOSAMADI
PANOLI
KHAROD
MOTALI
ANDALA
UTIYADARA
WINTER
SUMMER
MONSOON

4.2 RESULTS AND DISCUSSION OF PHYSICOCHEMICAL PARAMETERS FOR ANKLESHWAR TALUKA

Ground water samples were collected from fifteen different stations of Ankleshwar Taluka of Bharuch district, Gujarat. Data obtained were discussed for its minimum and maximum values in comparison of standard physicochemical parameters.

TDS

Salts, all nonvolatile materials and inorganic impurities are called Total Dissolved Solid. Upper limit of TDS is 1000 mg/L specified by World Health Organization in 1993. Higher level of total dissolved solid may cause kidney disease, calcium deposition, stone formation, etc. TDS include inorganic salts as well as small quantity of organics which are dissolved in water. So, TDS depicts a qualitative picture of dissolved solids not indicating the nature of ions and their relationship. TDS will affect odour and taste of the water. In some cases, dissolved solid contains very low amount of metals like arsenic and lead, which make water toxic and affects adversely the development and growth of children, Higher Values of TDS, also produce negative impact on vegetation and aquatic life, because at higher TDS, oxygen level decreases, which is essential for aquatic life. Variation of TDS values also change the pH of water making it misfit for survival of various species. Higher value of TDS also alters the quality of soils required for growth of plants and soil erosion also increases. Wildlife is adversely affected by higher value of TDS, because when wildlife use polluted water for long time, it can cause death also. Therefore, regular evaluation of TDS levels is the utmost-need to sustain clean environment. Present study shows that TDS comes at 400 to 800 mg/L value. Season wise lowest and highest values of the parameter are given below:

Higher value was found for **JETALI** station and Lower value was found for **PILUDRA** station during winter season.

Higher value was found for **JETALI** station and Lower value was found for **PILUDRA** station during summer season.

Higher value was found for **JETALI** station and Lower value was found for **SARTHAN** station during monsoon season.

pH

pH indicates the acidity and alkalinity of water. Acidic pH range is 0-7 and basic pH range is 7-14. Acceptable pH of water is 6.5-8.5 according to World Health Organization. Higher or lower Values of pH have negative impact on the lives of plants and human beings. Alkaline water causes irritation in eyes, skin and problems related to digestive system. Higher values of pH may cause dehydration due to reduction in absorption capacity of water by the human body. More alkaline water can also cause formation of stones in kidney due to building-up of calcium salts in urinary tract.

Also, acidic water (lover pH) can cause skin irritation, tooth decay and stomach uncomfort. Such water can also produce corrosion of metal pipes and fixtures, which will create water pollution of heavy metals, like copper, lead, etc. This will increase the risk of bladder cancer. Higher or lower values of pH of drinking water may disrupt the general functioning of various biological processes in human being. Higher pH or alkaline water is detrimental to plants growth due to the requirement of specific pH range for different vegetations. If pH value is much higher, then it will decrease the concentration of nutrients like Ca, Mg and Fe. The leaves of plants become yellow at higher pH value and growth is hampered and therefore plants may die. Water having lower pH will make the solid acidic and so important nutrients like Ca, Mg, K, etc will leach to make plants weak, thereby causing various plant diseases.

Life of flora and fauna is sensitive to the pH of water. A certain range of pH is essential for various organisms to survive. Deviation from the permissible range will affect their health adversely. Low pH of water can dissolve CaCO3, which is taken up by various aquatic organisms to form skeleton and shells. Acidic water will cause deformation, retarded growth and sometimes death of the species, like coral, snail and clams.

The solubility of various heavy metals is affected by the changes in pH values of water which becomes toxic for organisms of aquatic systems. Acidic water increases the toxicity of aluminium. It adversely affect the fish gills by reducing their ability of breathing. The pH of water also affects the amount of dissolved oxygen which is very much essential for aquatic life. The quantity of dissolved oxygen is reduced in water of low pH, which is harmful for fish and other species to take to breathe. This will cause death of fishes in water bodies. The pH value also affects the reproduction of aquatic organisms, Larvae cannot survive at low pH of water, eggs fish and in result, the decrease in populations is observed. Therefore, to sustain life, the pH should be maintained in the desired acceptable standard limits, so, it is necessary to test the pH of drinking water frequently for its safe utilization.

Higher values were found for **KHAROD** station and Lower values were found for **JETALI** station during winter season.

Higher values were found for **ANDALA** station and Lower values were found for **SANGPOR** station during summer season.

Higher values were found for **KHAROD** station and Lower values were found for **AVADAR** station during monsoon season.

Total Hardness (TH)

Water contains anions, cations, minerals such as salts magnesium and calcium. All these ions are responsible for the hardness of water. Acceptable value of total hardness for potable water is 300 mgL-1 according to WHO. Total hardness means total concentration of calcium and magnesium ions in mg L-1 (CaO3 equivalent). In ground water, it is found due to effluents from chemical and mining industries and also due to use of fertilizers in agriculture fields. Though higher values of TH is good for human health because it reduces the risk of cardiovascular diseases, cancer, etc but higher value may cause the problem of kidney stones also, Irritation and dryness of skin is another adverse effect of TH, Bones are strengthened by calcium but higher levels of TH may cause gastrointestinal problems due to its laxative functioning, result into diarrhea. Higher value of TH for water also impact on the development of plants. This is due to the fact that at higher TH, the soil became more alkaline and hence the nutrients will not be available to plants. However, citrus fruits plants grow more at higher TH. Animal behaviour and reproduction is also affected by higher levels of TH. Amphibians and few fishes need definite value of TH for their reproduction and development.

TH has significant effect on the species of aquatic life, which uses CaCO3 for their skeletal or shell formation. Low value of TH led to deformation and decrease their survival rates, whereas high value of TH may deposit minerals on their gills and other parts of the body. This well reduce the uptake of oxygen and so the survival is adversely affected. TH parameter is crucial for plants, human wellbeing and wildlife. Higher value of TH is sometimes advantageous but these are also disadvantageous in other ways. So, it is necessary to monitor TH of drinking water continuously

Higher value was found for **JETALI** station and Lower value was found for **KHAROD** station during winter season.

Higher value was found for **JETALI** station and Lower value was found for **PANOLI** station during summer season.

Higher value was found for **JETALI** station and Lower value was found for **UTIYADARA** station during monsoon season.

Calcium content

Calcium is required to strengthen our bones but excess level of calcium may cause kidney stone and other problems. Desirable limit for calcium is 75 to 200 mgL-1 in accordance with WHO. Calcium is very important and essential for our body. It can prevent the absorption of heavy metals in our body and enhance the bone mass. It also reduces the risk of some kinds of cancers. The value of hardness of water is directly associated with calcium content. Growth and development of teeth and bones are dependent on the calcium content of water we use for drinking. Calcium plays a vital role to regulate nerve and muscle functioning, blood clot, enzyme and hormone production, etc. Bone density is also affected by calcium in drinking water. If diet with low calcium is taken, chances of osteoporosis increases. The permissible content of calcium in drinking water is beneficial from protective point of view against heart problems due to its role in reducing blood pressure and improving the lipid distribution. Calcium is also required for healthy teeth, mainly in developing child having age 8 years. It prevents decaying of tooth. Depending upon the age, gender and constitution of human body, the optimum level of calcium is varied. Calcium is fruitful for the health as well as survival of various organisms. The exoskeletons and Shells formation largely depend upon the calcium. The proper quantity of calcium in water gives structural integrity to these organisms and therefore, deformation in skeletal structures is halted. Plants growth and development is also affected by calcium. The cell walls of the plants are protected by desired level of calcium in water, promoting the development of roots and increasing the absorption of nutrients. To sustain bones and teeth in animals also, calcium is very significant.

The proper concentration of calcium in drinking water enhance the growth and development of aquatic life, plants and wildlife. Lower Calcium Content enhances the probabilities of bone abnormalities. Looking to its important role, the concentration of calcium is necessary to determine in drinking water, such that a healthy environment is maintained and a balance among various nutrients is sustained.

Higher value was found for **PANOLI** station and Lower value was found for **UMARWADA** station during winter season.

Higher value was found for **PANOLI** station and Lower value was found for **UMARWADA** station during Season summer season.

Higher value was found for **PANOLI** station and Lower value was found for **TELVA** station during monsoon season.

Mg^{2+} content

To keep the digestion better in the body, Magnesium is the one of the important mineral but its values above the desirable value may led to irritation in gastrointestinal tract. Desirable value is 50 to 100 mgL-1 according to WHO. Magnesium content in drinking water is advantageous for health point of view, but at higher concentrations, it causes some health problems also. It is essentially required for proper functioning of cardio-vascular systems. It also causes laxative Impact when present in higher concentration. Hardness of water sample reflects the magnesium content of water and it is with calcium also, but magnesium content is always less than calcium content in drinking water. It is an important element in chlorophyll and flora growth is governed by its content.

Various physiological processes are governed by the magnesium. Its desired amount in drinking water makes our bones healthy but lover content of magnesium may cause osteoporosis also. Heart functions are properly maintained by magnesium content. Therefore, lower content of magnesium increases the risk of heart strokes, high blood pressure and various diseases related to cardiac systems. The lower content of magnesium can make our muscle weak and cramps, spasms and tremors can also occur. Magnesium is helpful to regulate insulin sensitively and amount of sugar in blood and therefore lower magnesium content car cause type 2 diabetes. The risk of rectal and colon cancer is also reduced by somewhat higher magnesium content in drinking water. The growth and survival of various organisms like fish, algae, invertebrates, etc depends on the magnesium content. Good scales and bones are the result of magnesium along with cell’s ionic balance regulation and enzymatic functions in cells. Lower magnesium content increases likelihood of diseases and produce harmful effect on growth, development and reproduction.

Plants also essentially require magnesium for their growth and development. Magnesium is essential for synthesis of chlorophyll, which is main pigment in photosynthesis. Lower magnesium content in water and soil affect the growth and yield in adverse manner. Lower value makes the plants more susceptible to pests and other diseases. Thus, it is essential and significant to maintain the magnesium content in water to sustain the balance of other nutrients to keep our environment healthy.

Higher value was found for **KHAROD** station and Lower value was found for **PANOLI** station during winter season.

Higher value was found for **ANDALA** station and Lower value was found for **PANOLI** station during summer season.

Higher value was found for **ANDALA** station and Lower value was found for **TELVA** station during monsoon season.

Chloride content

Most of water body possess chloride and more than 50% chloride is present in the common salt. Higher level of chloride may cause seance towards heart, kidney and laxative effect diseases. Desirable value is up to 250 mgL-1 according to WHO. Natural sources of water contain chloride and if taken in low quantity, it is non toxic for human beings. However, its adverse effects on health, plants, aquatic and wildlife at higher concentration has also been seen. Higher chloride content in drinking water gives a salty taste, so it will not be palatable. Therefore, to keep our body Just hydrated, its use has been limited. Higher chloride content produce dehydration in summer.

Those who have high blood pressure or any heart problems, they are at low sodium diet and if chloride content in drinking water is higher then such people are at high risk, as we know, chloride is very soluble in water, and highly stable, not degrading in water, so it will accumulate in water bodies. The internal salt level of fishes and various animals are affected by higher chloride content in water. Higher chloride content produces problems in the process to regulate salt balance in fishes and other aquatic animals. The higher chloride content may cause dehydration and in some cases, death also occur. High chloride content bring changes in aquatic plants and algae, and therefore, whole ecosystem is disturbed, High chloride content in Wetland has also impacted various kinds of plants which have cascading effects on the environment. If chloride content in water used for irrigation is high, then growth of crops and other plants is adversely affected. The uptake of nutrient and water by plants is affected by high content of chloride in water: This leads to wilting and plants remain underdeveloped.

The higher chloride content also affects the microorganisms which support the growth of plants. So, it is necessary to monitor chloride concentration in drinking water such that suitable methods can be used to control the high content of chloride, if any.

Higher value was found for **KHAROD** station and Lower value was found for **ANDALA** station during winter season.

Higher value was found for **KHAROD** station and Lower value was found for **ANDALA** station during summer season.

Higher value was found for **KHAROD** station and Lower value was found for **TELVA** station during monsoon season.

SO_4^{2-} content

As compared to chloride, the sulphate has very slight outcome on the test of water. Higher level of sulphate in comparison to desirable limit may cause intestinal disorder and diarrhea. Desirable value is from 200 to 400 mgL-1 according to WHO. Sulphate is an important nutrient and has significant role to form protein and other compounds in our body. Its antioxidant property help protects against some chronic diseases. Higher sulphate content leads to gastrointestinal distress, like diarrhea and dehydration. Sulphate increases water solubility of metals by forming various harmful compounds which are detrimental to human health. The higher sulphate content in drinking water have varied effects on plants, vegetable and animal life, depending upon the amount and time period to which it is exposed. Invertebrates and fishes are affected by its toxic effects, resulting in to reduced population and disruption of environment. Uptake of nutrients by plants is also adversely affected by higher content of sulphate in water, which causes reduction in development and productivity of plants, Higher sulphate content produce a cascading impact on the whole eco-system because plant is the basis of various food webs. Higher sulphate content can change the pH as well as the soil chemistry, this will affect the capacity of animals to use nutrients. Some kinds of wildlife development and reproduction is also affected by higher content of sulphate, Higher concentration of sulphate results in to decrease in oxygen content, which is detrimental to the survival of aquatic organisms because they require Oxygen to survive.

So, it is significant to monitor the sulphate content in water for adopting a right strategy to reduce its high concentration.

Higher value was found for **SANGPOR** station and Lower value was found for **PIPROD** station during winter season.

Higher value was found for **SANGPOR** station and Lower value was found for **ANDALA** station during summer season.

Higher value was found for **SANGPOR** station and Lower value was found for **ANDALA** station during monsoon season.

NO_3^- content

Nitrate is available in combined form such as nitrogen, which is one of the important components for the plant growth. If nitrate containing water is used for preparation of food, it will cause diarrhea in child and adult as well as blue baby syndrome. Desirable value is up to 45 mgL-1 according to WHO. Nitrate content in water source has good and bad impacts on human beings. High content of nitrate in drinking water leads to serious problem in pregnant women and infants. It is known that higher concentration of nitrate causes methemoglobinemia (blue baby syndrome).

It is also knows as a natural antimicrobial agent which protect us against bacterial infections. Nitrate can be changed to nitric oxide in the body which improve the blood flow and decrease the blood pressure, thus reducing the risk of cardiovascular and heart problems. It is a neurotransmitter helping the signal process in neurons. It also has antioxidant properly as well as anti-inflammatory nature. Nitrate is essential for plant growth and that's why it is used in fertilizers for agriculture proposes. Aquatic life is also negativity affected by high content of nitrate, because it results in to a phenomenon known as eutrophication, which produce fast growth of algae and other plants leading to reduction in oxygen levels in water, thereby fish and various species can die. The aquatic food web is also affected by high content of nitrate. Consequently, whole ecosystem is affected. This will cause proliferation of some kinds of bacteria, interfering to advantageous bacteria, therefore, total balance of environment is disrupted So, to sustain life of human beings as well as plant kingdom, nitrate content is necessarily monitored and maintained at the permissible limit. No relaxation is given by WHO for recommended value of Nitrate concentration in water.

Higher value was found for **PARDI MOKHA** station and Lower value was found for **KHAROD** station during winter season.

Higher value was found for **PARDI MOKHA** station and Lower value was found for **KHAROD** station during summer season.

Higher value was found for **PARDI MOKHA** station and Lower value was found for **KHAROD** station during monsoon season.

Fluoride content

Number of minerals are soluble in water because they form salt with the fluoride. Fluorosis, porous bone disease is caused by the excess limit of the fluoride ion. Desirable value is 0.6 to 1. mgL^{-1} according to WHO. As compared to surface water, Fluoride is found more in ground water. Dental health is associated with the fluoride content in water, but when it is present in permissible limits only, otherwise higher values of fluoride content in drinking water can cause tooth-decay as well as serious disease known as skeletal fluorosis. Fluoride gives strength to enamel of the tooth so that tooth become ristant to acid from bacteria in mouth. The early sign like white spots on teeth is prevented by fluoride content in water. Higher content of fluoride can cause dental fluorosis. Due to higher content of fluoride and long-term use of such drinking water, the serious problems like lead skeletal fluorosis occur, in which stiffness, joint pain, ligament and bones are damaged. It also causes thyroid problem, infertility and cognitive ability is adversely affected. High content of fluoride become toxic for aquatic life, like amphibian and fishes. The various functions of enzymes and biological processes are disrupted by the intervention of fluoride, in aquatic fauna also. Wildlife is also adversely affected by higher content of fluoride in drinking water. The growth and health of agricultural corps are negatively affected, when irrigated with high fluoride content water, because, fluoride interferes uptaking of nutrients and water by plants which lead to wilting. So, it is necessary to monitor water sources regularly for fluoride content such that defluoridation techniques may be applied to high fluoride content water.

Higher value was found for **KHAROD** station and Lower value was found for **SARTHAN** station during winter season.

Higher value was found for **UTIYADARA** station and Lower value was found for **PANOLI** station during summer season.

Higher value was found for **UTIYADARA** station and Lower value was found for **SARTHAN** station during monsoon season.

Alkalinity

Water is alkaline because of presence of carbonates, bicarbonates and hydroxides. It is nothing but ability of water to neutralize acidity. Desirable value is up to 600 mgL^{-1} according to WHO. Alkalinity of waters is mainly due to dissolved carbonates, bicarbonates and hydroxides - Alkalinity of water is different from pH, though it is the capacity of water to neutralize acidity. The permissible range of alkalinity for water irrigation is 0-100 mg L^{-1} $CaCO_3$. The value between 30 and 60 mg L^{-1} are optimum for most of the plants. High alkalinity affects the plant nutrition. High alkalinity significantly affects the growing medium fertility.

Water of moderate alkalinity is advantageous because it became an important source of Calcium and Magnesium. Two billion tonnes of various alkaline residue are produced every year globally, this residue comes from alumina refining, and Coal based power plants. Such water is stored in landfills which is hazardous to health and environment. Borates, phosphates and silicates also contribute to alkalinity of water. Alkalinity is significant when the suitability of water for irrigation and mixing of pesticides is done. Alkalinity also affect soil quality and change the pH. The health impacts of alkalinity are important: alkalinity plays virtual trole for aquatic ecosystems, affecting the health of rivers, lakes, and ocean. It acts as natural buffer; Moderate alkalinity of drinking water is beneficial for health which improve digestion and reduce the acid reflux. It also increases hydration. Proper alkalinity of wate is good for irrigation which gives stability to soil and increase availability of nutrients. Therefore, alkalinity of water is important to sustain health and life. Therefore, monitoring alkalinity levels in drinking water will be a pro-active step for overall wellbeing.

Higher value was found for **KHAROD** station and Lower value was found for **ANDALA** station during winter season.

Higher value was found for **KHAROD** station and Lower value was found for **UTIYADARA** station during summer season.

Higher value was found for **AVADAR** station and Lower value was found for **UTIYADARA** station during monsoon season.

Turbidity

Desirable value is 10 NTU for drinking water according to WHO. Turbidity decreases the clarity of water samples. Turbidity is due to suspended matter which absorb or scatter light Water's called turbid if the suspended particles are harmful for health, Suspended materials reduce the light penetration, mainly inorganic suspended matter. It is different from total suspended solids (TSS). Turbidity implies light scattering properties of water samples It is "haziness" and this is due to fine particles which scatters light at about 90° to the direction from. Which light enters the sample. Turbidity should not be confused with colour or vice-versa. It is measured by a Turbidity Meter and expressed in Nephelometric Turbidity Units (NTU). Purified water should have turbidity <1 NTU. Higher Turbidity produce negative impact on aquatic life. It clogs fish gills, hinder the visibility and decreases light penetration affecting adversely the aquatic plants. High turbidity also reduces fish resistance to various diseases. It affects the developments of larva and eggs. Higher turbidity also increases temperature of water and decrease the amount of dissolved oxygen because of enhanced heat absorption by water: Decrease in light penetration decrease the dissolved oxygen, content, thereby reducing the photosynthesis of aquatic plants. Hence aquatic life and human health, both are affected by high turbidity water. So, it is necessary to monitor turbidity of drinking water regularly.

Higher value was found for **SANGPOR** station and Lower value was found for **ANDALA** station during winter season.

Higher value was found for **JETALI** station and Lower value was found for **ANDALA** station during summer season.

Higher value was found for **PARDI** station and Lower value was found for **ANDALA** station during monsoon season.

Chemical Oxygen Demand (COD)

It is one of the significant properties of drinking water. It is the amount of oxygen needed for oxidation of chemical compounds present in water. It is a significant parameter for quality of water. Higher values of COD reflect the pollution of water present due to organics and inorganic compounds. Higher COD values of water samples decreases the concentration of dissolved oxygen in water, which is detrimental for aquatic life. Eutrophication is also caused by higher COD, which resulted in to reduced level of dissolved oxygen. Therefore, fishes and various aquatic organisms are at risk for their survival. The changes in weather pattern and temperature or climate change also affect the value of COD because these climatic changes result in to change in the concentration of pollutants in water. Therefore, to known the level of water pollution, it is necessary to determine COD, such that appropriate technique is to be used for removing pollution due to organic and inorganic compounds in water. Majority of ground water having dissolve oxygen level of 4.2 to 6.0 mgL^{-1}. Desirable limit is 3 mgL^{-1} according to WHO. Water with saturated oxygen levels gives very pleasant test. Water with less dissolve oxygen value than desirable limit is fetal for aquatic animals.

Higher value was found for **TELVA** station and Lower value was found for **ANDALA** station during winter season.

Higher value was found for **TELVA** station and Lower value was found for **KOSAMADI** station during summer season.

Higher value was found for **SANGPOR** station and Lower value was found for **UTIYADARA** station during monsoon season.

Biological Oxygen Demand (BOD)

It is the quantity of oxygen required by microorganisms for decomposition of organic matter present in water. Like, COD, BOD is also an important parameter to assess the water pollutions, Higher BOD means more polluted water because higher value of BOD indicates the presence of more quantity of organic matter in water. This will decrease the concentration of dissolved oxygen, putting aquatic life at risk, Higher BOD value also produce eutrophication due to which, increase in the growth of algae and other aquatic plants has been observed. Again, this will also decrease the dissolved oxygen levels in water.

Higher BOD Value of drinking water is harmful for health of human beings. When the untreated sewage and human waste is mixed in waterbodies, the BOD of water increases. Pollution due to higher BOD may leads to diseases like dysentery and Cholera also. So, it is significant to monitor BOD value of water samples to sustain aquatic ecosystem and health of people.

High BOD level indicates less dissolved oxygen. Plant kingdom to survive in the water are due to nitrate and phosphate salts present in the water. World Health Organization recommended the water having dissolve oxygen value 30 mgL^{-1}.

Higher value was found for **JETALI** station and Lower value was found for **PANOLI** station during winter season.

Higher value was found for **SARTHAN** station and Lower value was found for **UTIYADARA** station during summer season.

Higher value was found for **SARTHAN** station and Lower value was found for **KHAROD** station during monsoon season.

Dissolved Oxygen (DO)

Dissolved oxygen in water is the utmost requirement to sustain the life of aquatic environment, wildlife and human beings. It is very Important parameter because respiration and metabolism of aquatic organisms largely depends on this dissolved oxygen, Oxygen is needed for aquatic organisms like crustacean, fish and others to derive energy from their food to sustain their metabolism Hypoxia (oxygen deficiency) is caused to aquatic organism if dissolved oxygen level is low enough, and also anoxia (lack of oxygen) cause death of these organisms. At higher temperature, the amount of oxygen decreases in water resulting in to the conditions of hypoxia or anoxia. Biodiversity is also adversely affected by low levels of oxygen in water, because same species are more sensitive towards lower amount of oxygen than other species. Also, some species can survive even in low oxygen content whereas others cannot.

Human health is also affected by dissolved oxygen in water. The low amount of oxygen indicates pollution due to nutrients where growth of bad algae increases and they produce toxic substances, which are harmful to human health. In coastal areas, the concentration of oxygen is naturally at low levels, there needs the oxygen masks or other breathing equipment’s for proper functioning of lungs. Therefore, it is very necessary to monitor the amount of dissolved oxygen in water for its quality requirement to sustain aquatic systems, plants and wildlife.

Higher value was found for **AVADAR** station and Lower value was found for **SARTHAN** station during winter season.

Higher value was found for **PIPROD** station and Lower value was found for **SARTHAN** station during summer season.

Higher value was found for **PIPROD** station and Lower value was found for **PANOLI** station during monsoon season.

Physicochemical parameters of Bharuch Taluka

Ground water analysis of water samples collected from 15 stations of BHARUCH TALUKA of BHARUCH DISTRICT such as ADOL, AMDADA, AMLESHWAR, BAMBUSAR, BHUVA, CHOLAD, DABHALI, GHODI, HALDAR, KARELA, KELOD, OSARA, SAMLOD, SEGVA AND SHAHPURA.

All parameters were measured in terms of pH, Fluoride, Nitrate, Hardness, Alkalinity, Phosphate, Ca^{2+}, Mg^{2+}, Sulphate ion, COD, BOD. TDS and Total dissolved oxygen, etc. All parameters were measured in winter, summer and monsoon season.

Table 4.4: Physicochemical Parameter of Ground Water from Bharuch Taluka of Bharuch District, Gujarat (Winter)

Physicochemical parameters															
Sr. No.	Station Name	TDS mg/L	pH	Total Hardness mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Cl^{1-} mg/L	SO_4^{2-} mg/L	NO_3^{1-} mg/L	F^{1-} mg/L	ALKALINITY mg/L	TURBIDITY NTU	COD mg/L	BOD mg/L	DO mg/L
1	ADOL	628	6.85	385	38	31	80	52	16.18	0.2	422	3.5	12	7	0.62
2	AMDADA	510	6.92	375	35	46	72	35	19.10	0.3	430	3.8	15	6	0.80
3	AMLESHWAR	615	7.02	385	60	23	98	40	20.22	0.4	322	2.6	11	2	0.80
4	BAMBUSAR	535	7.01	380	39	54	120	38	18.21	0.3	318	2.6	14	3	0.84
5	BHUVA	486	6.91	378	38	32	88	42	15.80	0.1	422	3.7	15	8	0.78
6	CHOLAD	504	6.99	380	38	38	38	35	15.36	0.4	410	2.4	17	8	0.91
7	DABHALI	448	7.03	360	38	33	75	40	10.22	0.3	316	2.3	10	9	0.95
8	GHODI	594	7.00	365	36	32	80	41	8.11	1.2	435	3.6	15	8	0.82
9	HALDAR	545	7.10	300	35	33	88	45	10.12	0.3	321	3.7	16	7	0.75

10	KARELA	515	7.42	302	34	32	108	38	12.12	0.4	290	3.6	13	8	0.72
11	KELOD	580	7.10	280	38	31	85	36	17.35	1.1	293	3.7	12	6	0.32
12	OSARA	742	7.70	265	36	33	110	34	13.14	0.6	368	2.6	11	10	0.75
13	SAMLOD	744	6.82	390	39	31	108	35	16.20	0.5	365	3.8	14	8	0.63
14	SEGVA	485	6.81	375	41	40	95	42	15.82	0.2	314	1.5	13	7	0.81
15	SHAHPURA	636	7.60	257	38	32	75	49	8.52	0.2	310	2.8	13	5	0.60

Table 4.5 Physicochemical Parameter of Ground Water from Bharuch Taluka of Bharuch District, Gujarat (Summer)

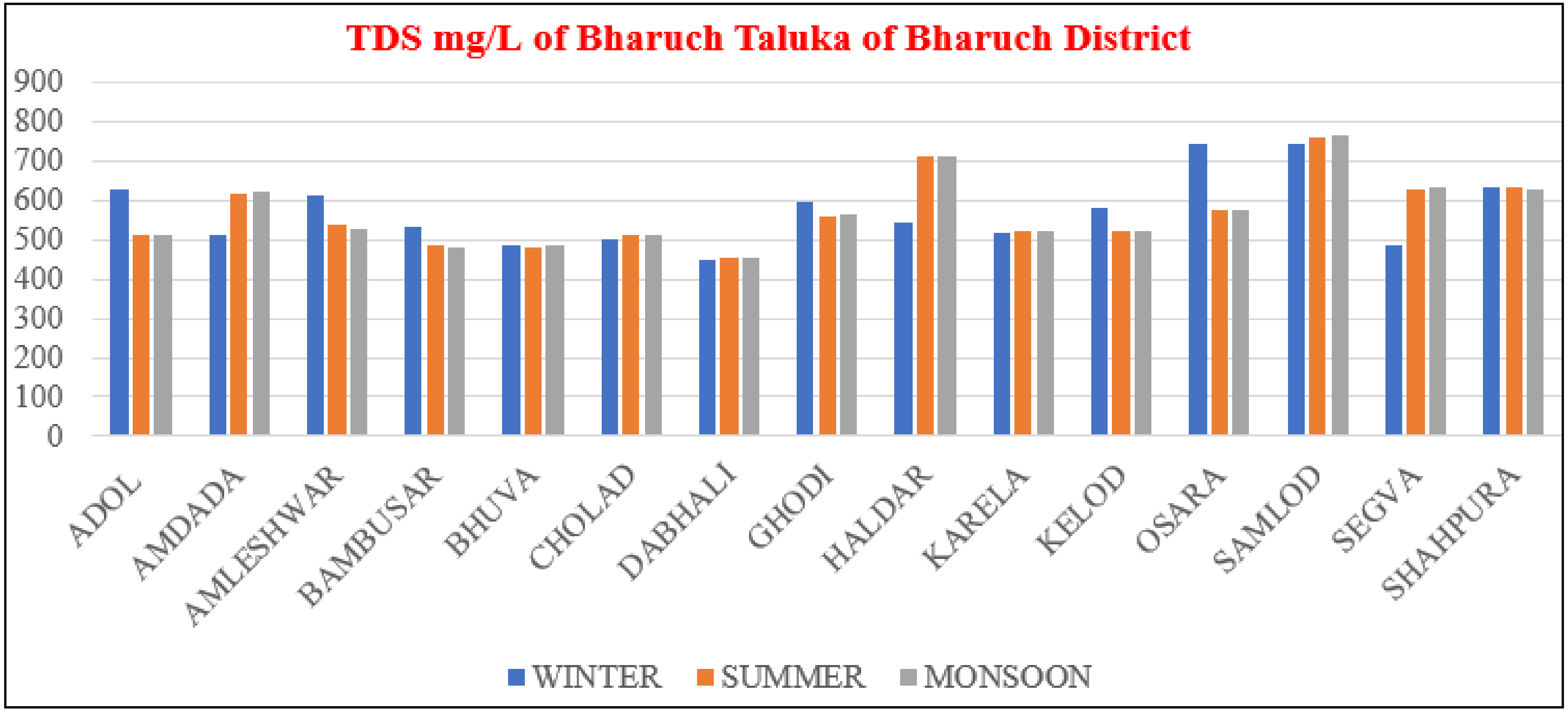
Physicochemical parameters															
Sr. No.	Station Name	TDS mg/L	pH	Total Hardness mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Cl^{1-} mg/L	SO_4^{2-} mg/L	NO_3^{1-} mg/L	F^{1-} mg/L	ALKALINITY mg/L	TURBIDITY NTU	COD mg/L	BOD mg/L	DO mg/L
1	ADOL	512	6.85	360	42	35	96	42	11.25	0.1	315	3.6	17	8	0.74
2	AMDADA	620	6.72	370	34	36	70	39	8.50	1.1	312	2.7	18	8	0.38
3	AMLESHWAR	540	7.12	258	35	35	122	41	8.10	0.5	433	3.8	10	3	0.70
4	BAMBUSAR	487	7.75	268	36	48	82	34	10.14	0.2	329	1.2	12	4	0.60
5	BHUVA	481	7.20	310	62	32	40	40	12.10	1.2	292	2.7	14	4	0.84
6	CHOLAD	510	7.40	319	37	34	92	39	17.30	0.3	294	2.4	17	5	0.62
7	DABHALI	452	7.14	290	39	30	81	46	19.10	0.4	430	2.3	11	2	0.92
8	GHODI	560	7.15	360	38	35	82	40	21.24	0.5	315	3.2	12	7	0.82

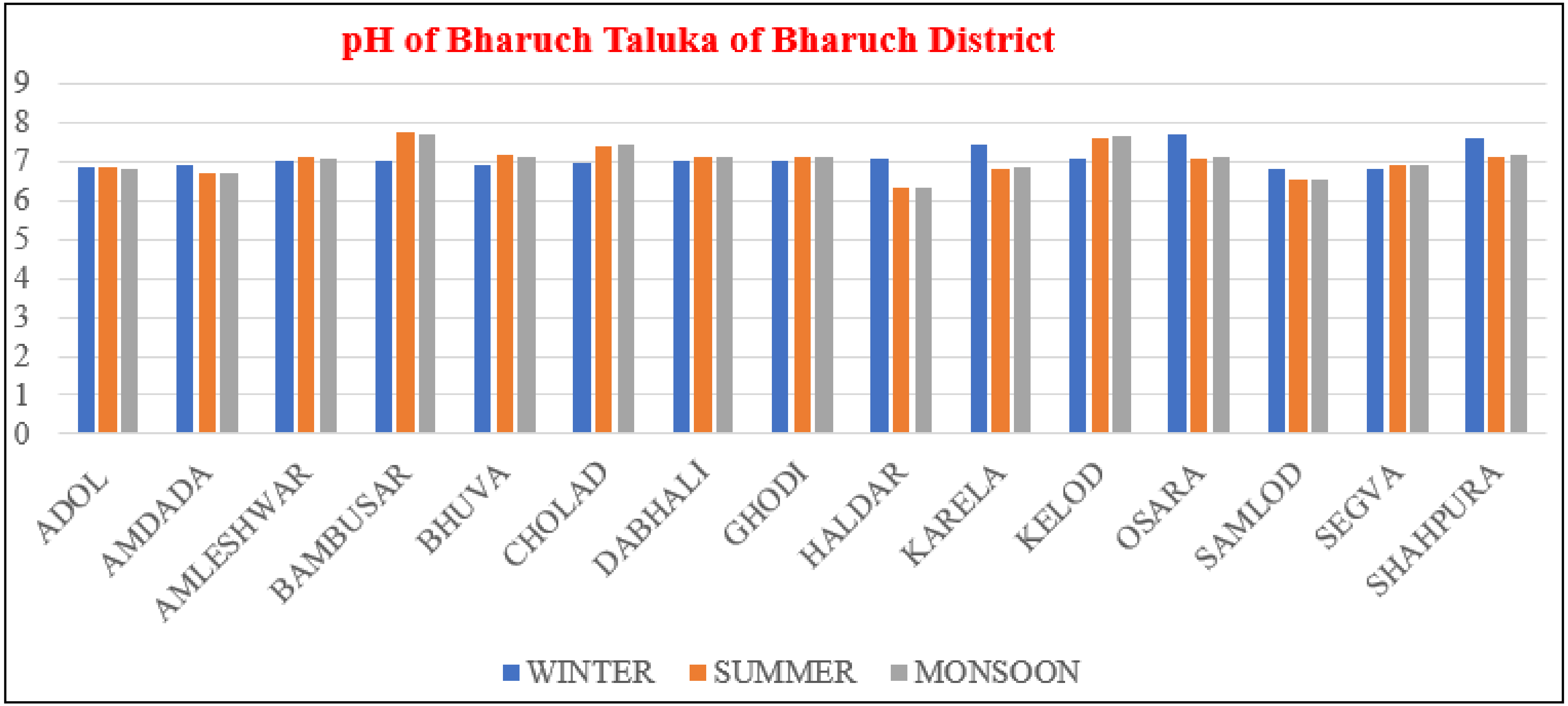
9	HALDAR	712	6.35	392	36	30	105	50	19.21	0.4	314	3.7	14	9	0.73
10	KARELA	520	6.81	380	37	32	86	36	15.81	0.3	430	3.2	16	8	0.62
11	KELOD	520	7.61	372	40	83	112	42	14.80	0.2	410	3.5	14	7	0.81
12	OSARA	575	7.10	378	41	42	82	42	13.36	0.3	320	3.8	13	5	0.82
13	SAMLOD	760	6.56	380	29	30	75	46	12.22	0.4	370	2.7	12	8	0.84
14	SEGVA	630	6.90	385	30	25	95	39	13.15	0.7	360	2.6	14	7	0.73
15	SHAHPURA	635	7.15	382	40	58	71	38	16.22	0.6	365	3.9	12	8	0.84

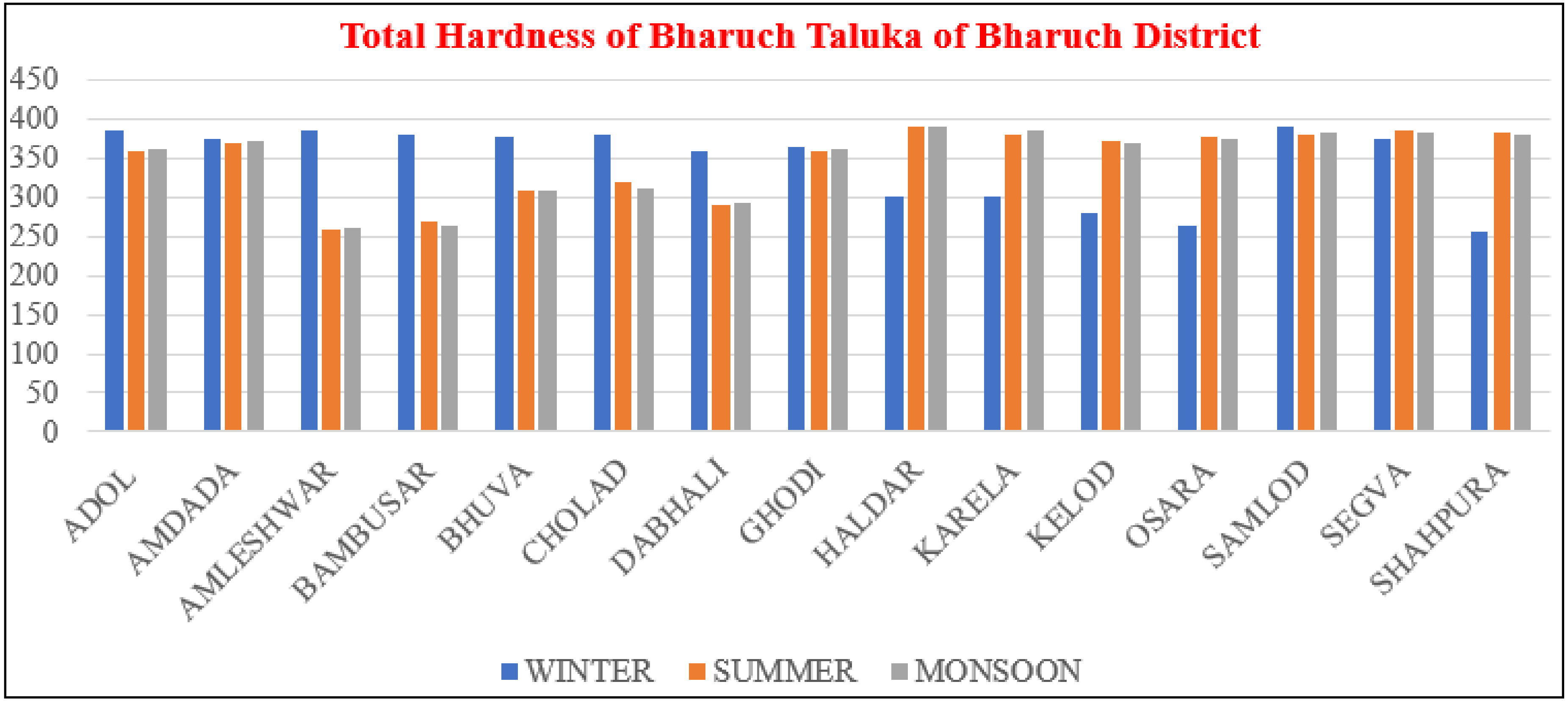
Table 4.6: Physicochemical Parameter of Ground Water from Bharuch Taluka of Bharuch District, Gujarat (Monsoon)

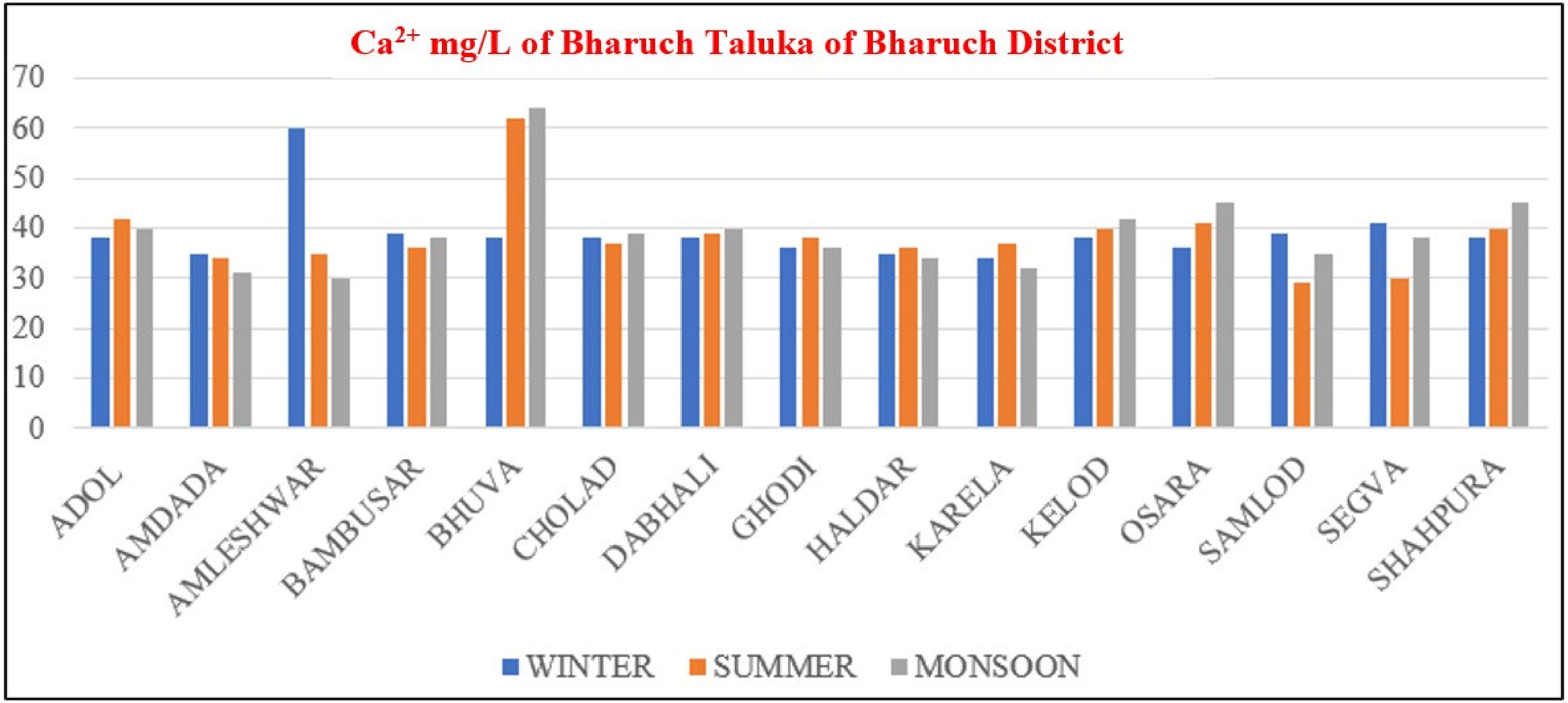
Physicochemical parameters															
Sr. No.	Station Name	TDS mg/L	pH	Total Hardness mg/L	Ca^{2+} mg/L	Mg^{2+} mg/L	Cl^{1-} mg/L	SO_4^{2-} mg/L	NO_3^{1-} mg/L	F^{1-} mg/L	ALKALINITY mg/L	TURBIDITY NTU	COD mg/L	BOD mg/L	DO mg/L
1	ADOL	514	6.80	362	40	34	94	44	11.20	0.2	316	3.7	18	8	0.72
2	AMDADA	625	6.70	372	31	30	72	30	8.52	1.2	314	2.8	19	7	0.30
3	AMLESHWAR	530	7.10	260	30	36	120	42	8.12	0.4	432	3.6	12	4	0.72
4	BAMBUSAR	480	7.70	264	38	40	83	35	10.13	0.3	328	1.3	14	3	0.61
5	BHUVA	486	7.15	309	64	31	42	45	12.12	1.3	291	2.8	13	2	0.82
6	CHOLAD	512	7.45	312	39	36	91	38	17.32	0.4	292	2.5	15	6	0.60
7	DABHALI	455	7.13	292	40	35	80	45	19.12	0.5	432	2.4	12	4	0.91
8	GHODI	565	7.14	362	36	36	85	42	21.20	0.4	316	3.4	13	6	0.86

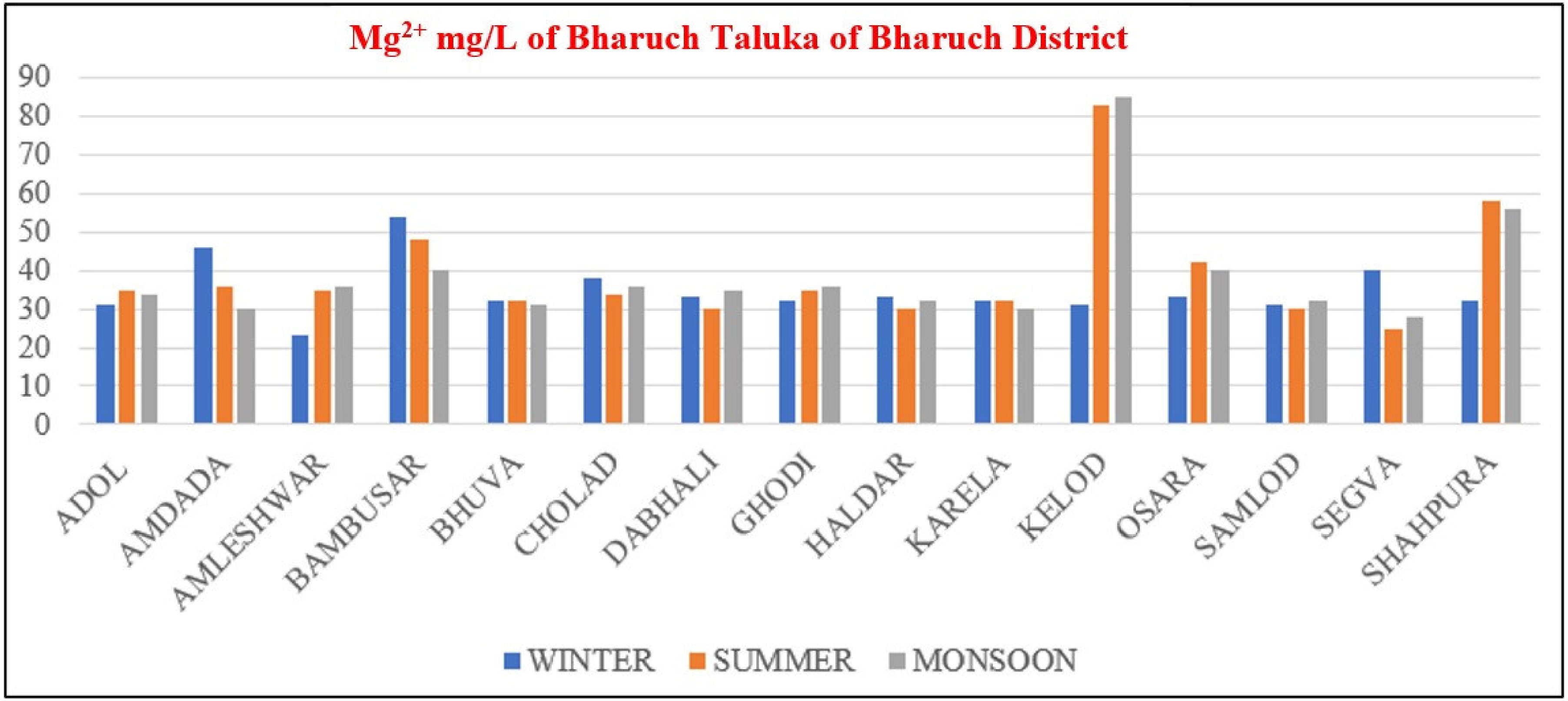
9	HALDAR	714	6.36	390	34	32	106	49	19.20	0.5	315	3.9	14	9	0.72
10	KARELA	522	6.85	385	32	30	87	38	15.80	0.4	434	3.4	18	8	0.65
11	KELOD	521	7.65	370	42	85	114	43	14.82	0.3	412	3.6	15	6	0.85
12	OSARA	576	7.15	374	45	40	83	43	13.35	0.4	322	3.5	13	4	0.84
13	SAMLOD	764	6.54	383	35	32	78	44	12.20	0.5	360	2.8	14	8	0.83
14	SEGVA	633	6.92	382	38	28	99	38	13.14	0.6	365	2.7	10	6	0.75
15	SHAHPURA	630	7.20	380	45	56	72	32	16.20	0.5	363	3.2	13	7	0.86

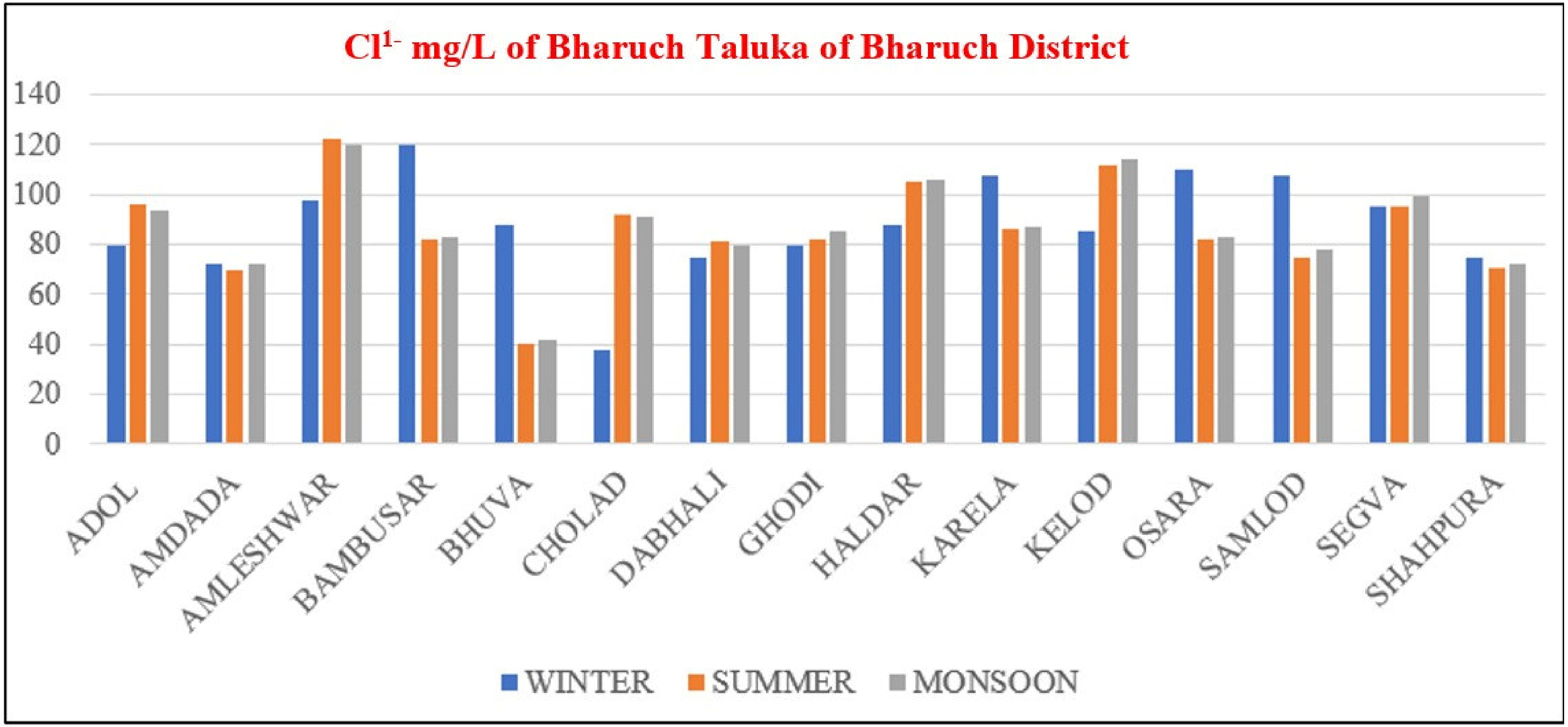

TDS mg/L of Bharuch Taluka of Bharuch District
900
800
700
600
500
400
300
200
100
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON

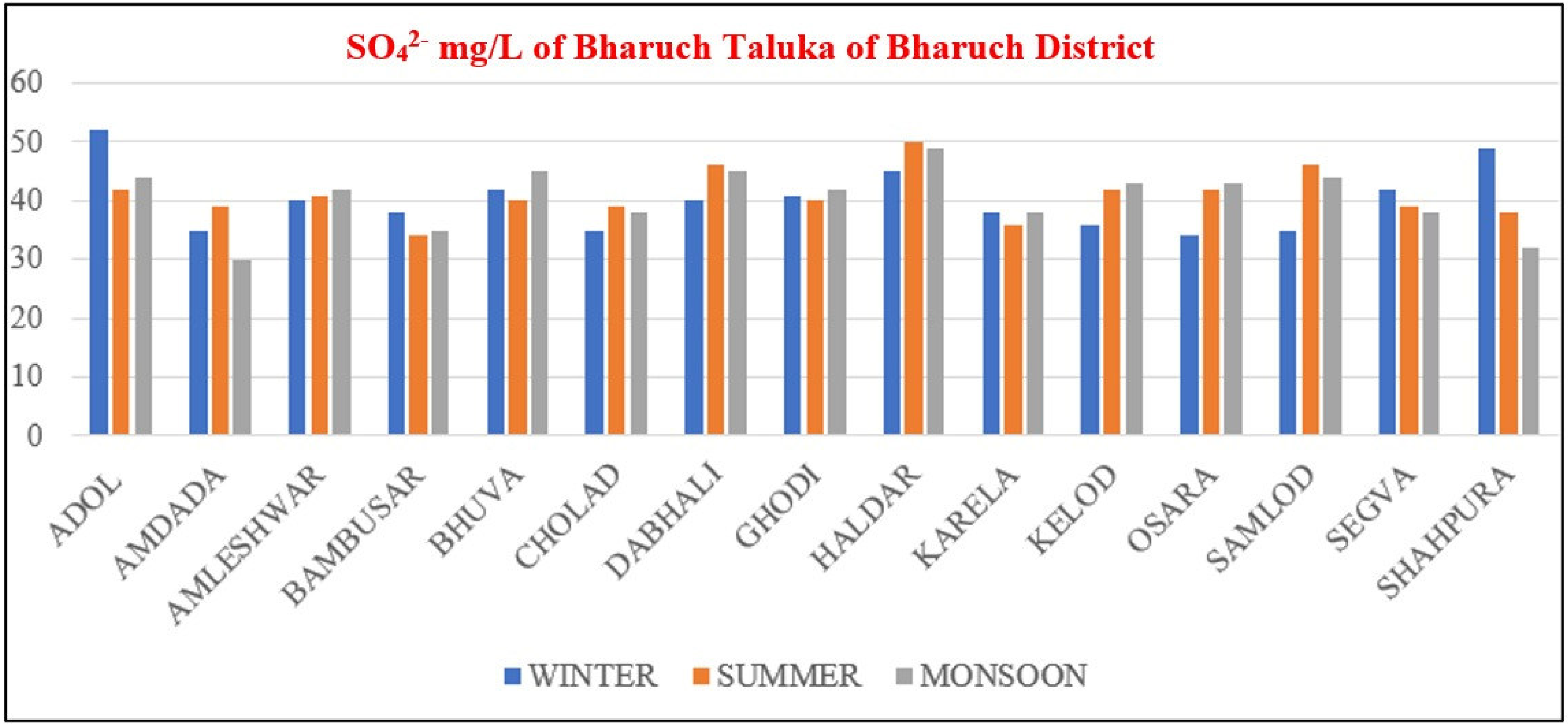

pH of Bharuch Taluka of Bharuch District
9
8
7
6
5
4
3
2
1
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON

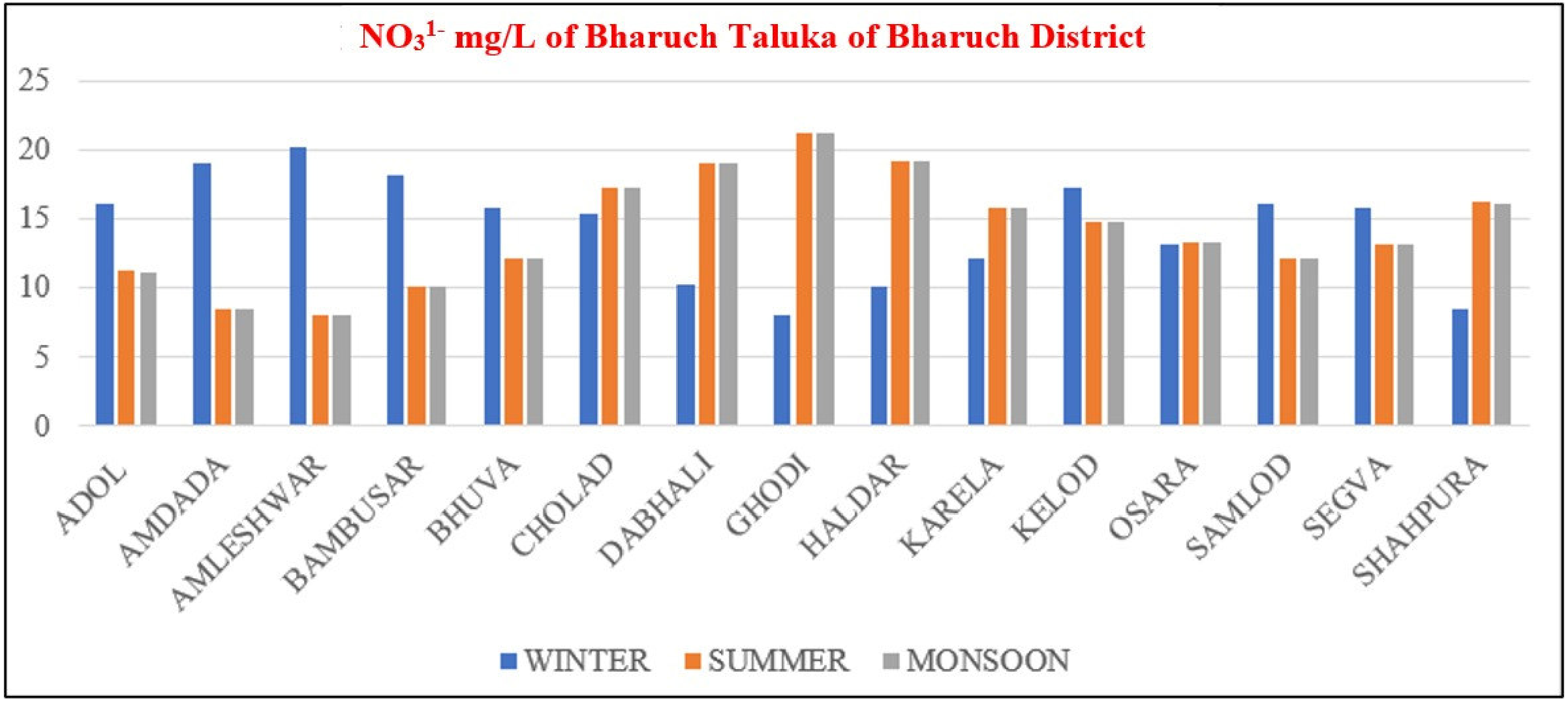

Total Hardness of Bharuch Taluka of Bharuch District
450
400
350
300
250
200
150
100
50
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON

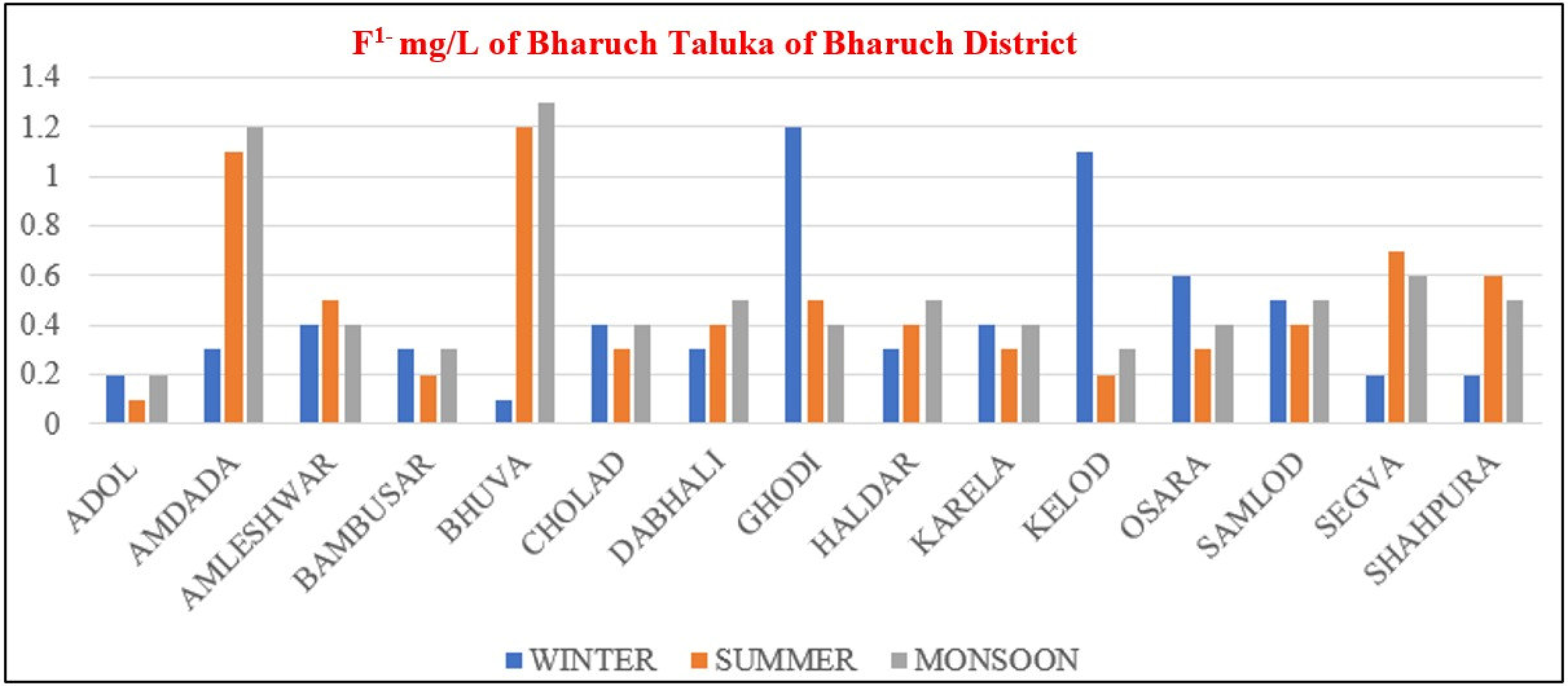

Ca2+ mg/L of Bharuch Taluka of Bharuch District
70
60
50
40
30
20
10
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON


Mg²⁺ mg/L of Bharuch Taluka of Bharuch District
90
80
70
60
50
40
30
20
10
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON

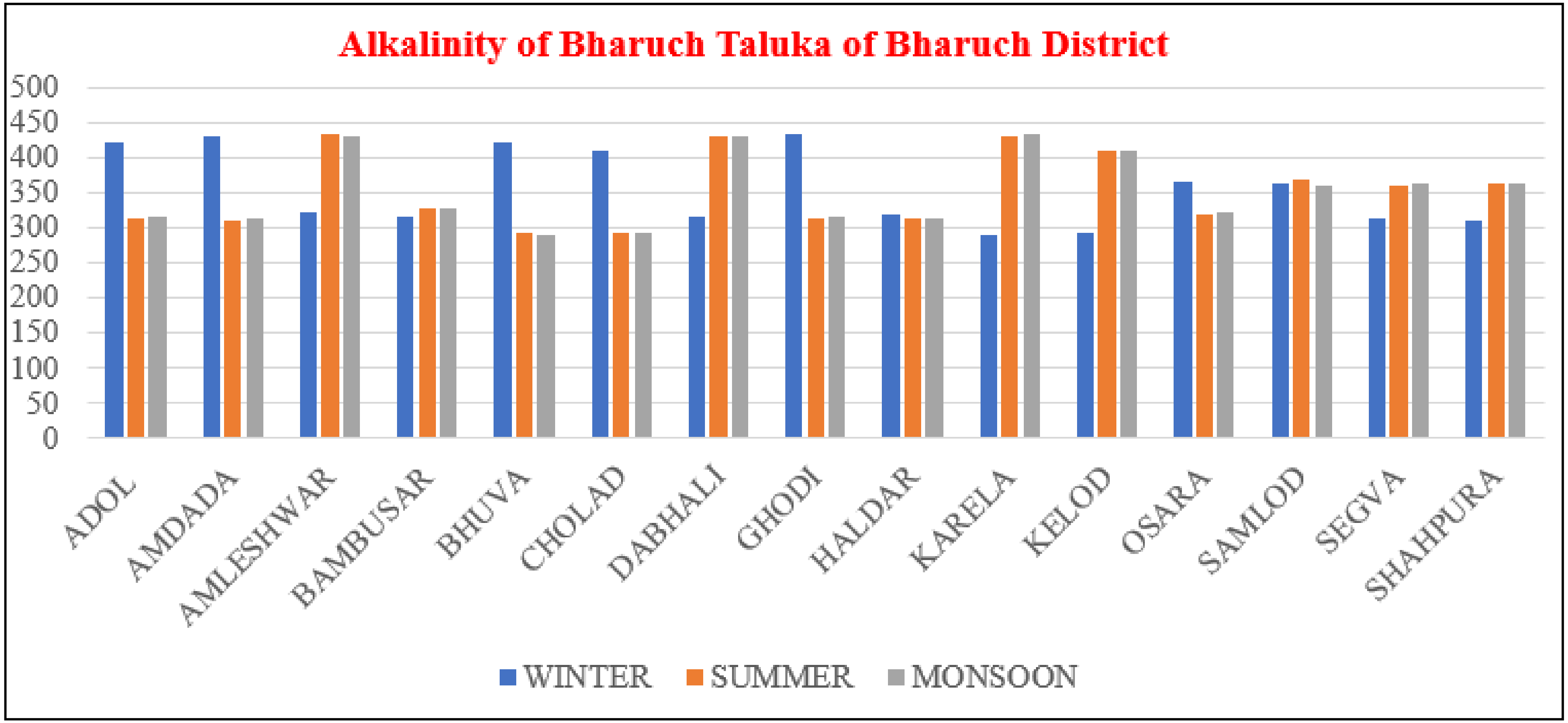

Cl1- mg/L of Bharuch Taluka of Bharuch District
140
120
100
80
60
40
20
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON

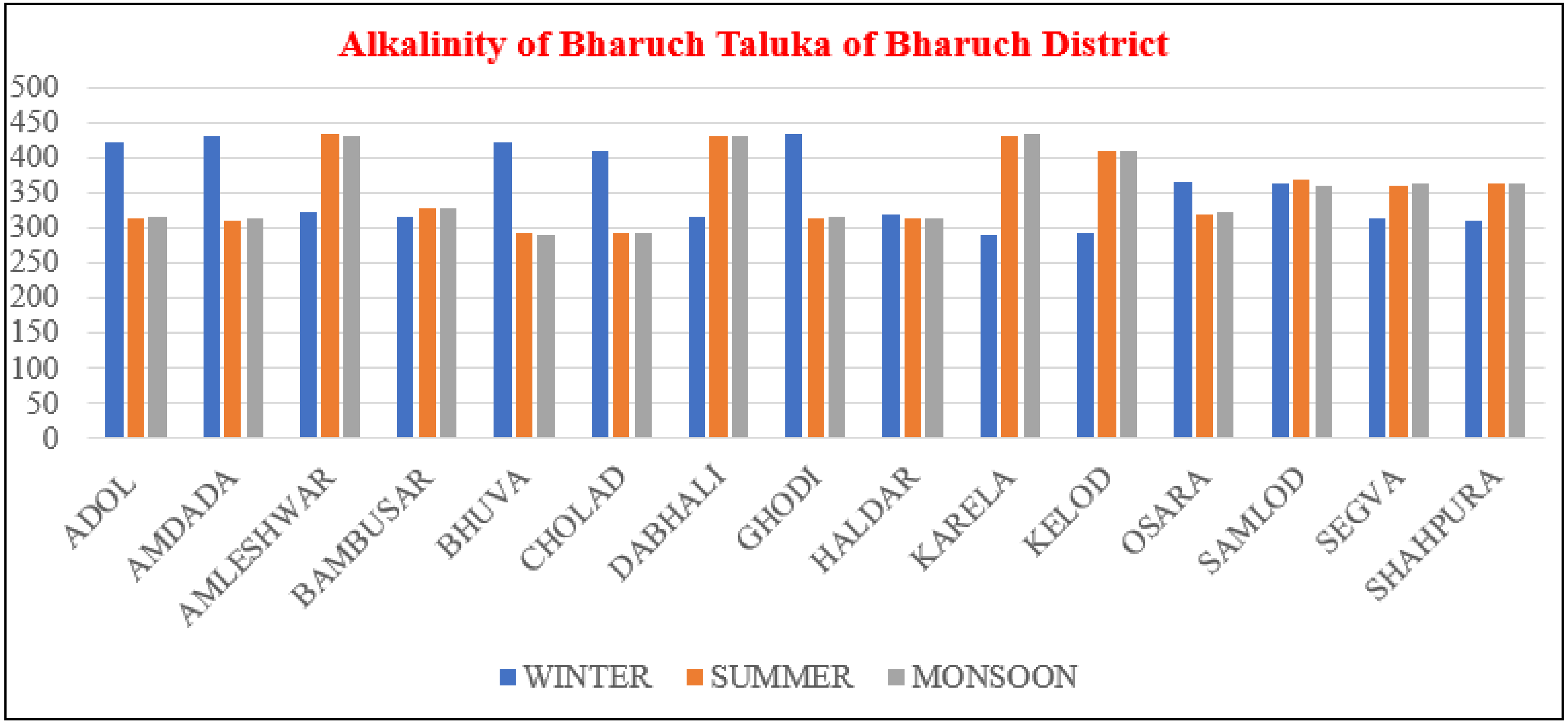

SO_4^{2-} mg/L of Bharuch Taluka of Bharuch District
60
50
40
30
20
10
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON

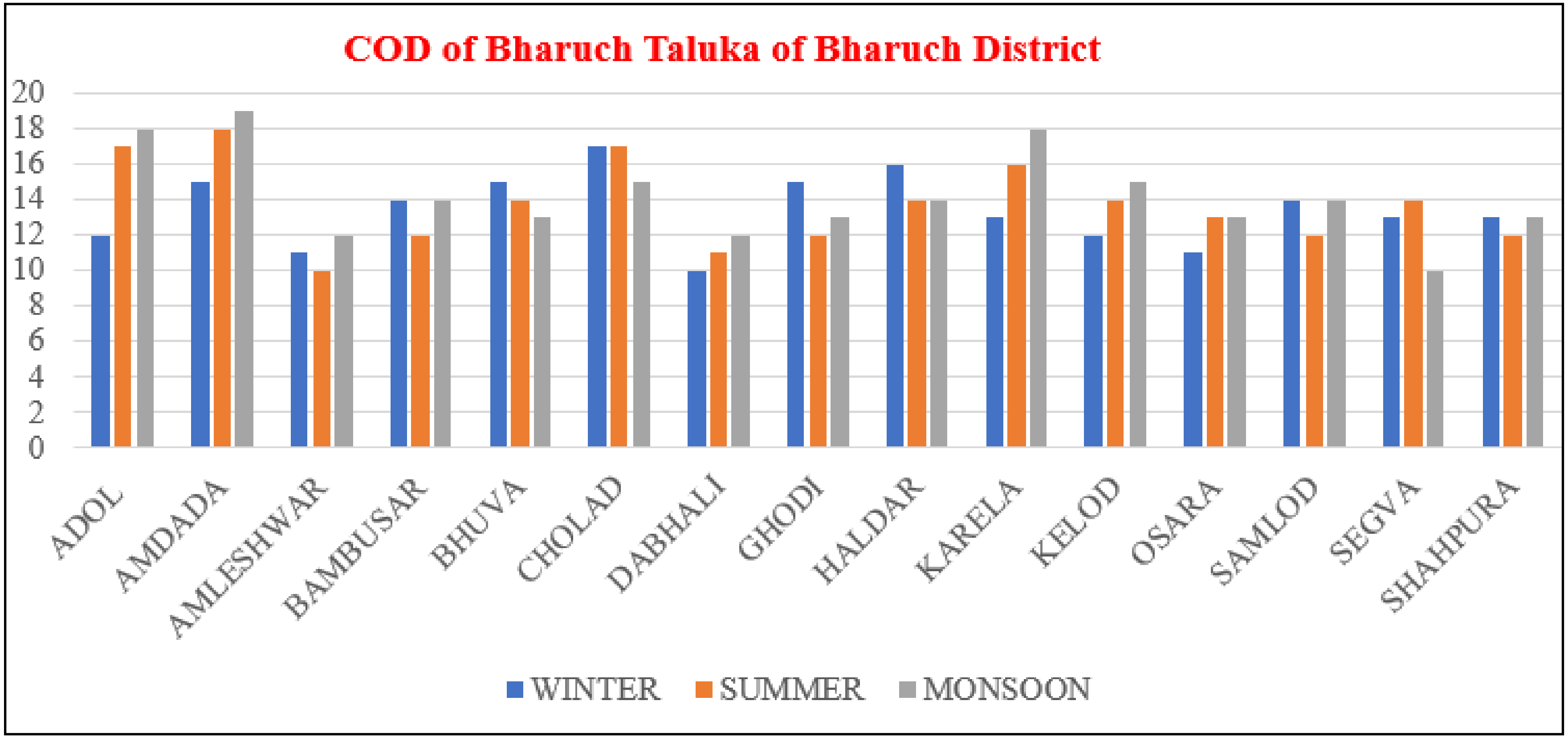

NO_3^{1-} mg/L of Bharuch Taluka of Bharuch District
25
20
15
10
5
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON

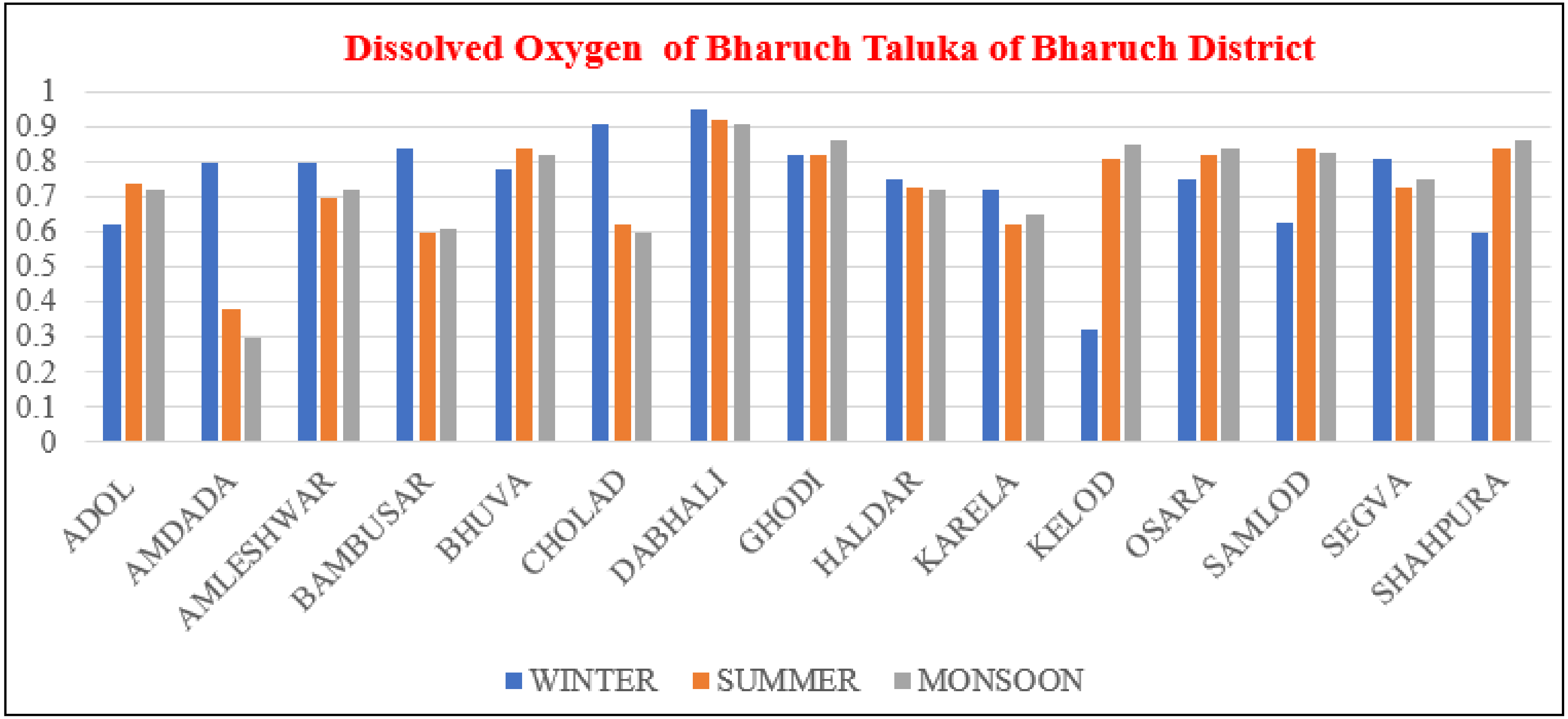


F1- mg/L of Bharuch Taluka of Bharuch District
1.4
1.2
1
0.8
0.6
0.4
0.2
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON


Alkalinity of Bharuch Taluka of Bharuch District
500
450
400
350
300
250
200
150
100
50
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON


Alkalinity of Bharuch Taluka of Bharuch District
500
450
400
350
300
250
200
150
100
50
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON


COD of Bharuch Taluka of Bharuch District
20
18
16
14
12
10
8
6
4
2
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON


Dissolved Oxygen of Bharuch Taluka of Bharuch District
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
ADOL
AMDADA
AMLESHWAR
BAMBUSAR
BHUVA
CHOLAD
DABHALI
GHODI
HALDAR
KARELA
KELOD
OSARA
SAMLOD
SEGVA
SHAHPURA
WINTER
SUMMER
MONSOON

4.4 RESULTS AND DISCUSSION OF PHYSICOCHEMICAL PARAMETERS FOR BHARUCH TALUKA

Ground water sample were collected from fifteen different stations of Bharuch Taluka of Bharuch district, Gujarat. Data obtained are discussed for its minimum and maximum values in comparison to standard value.

TDS

Salts, all nonvolatile materials and inorganic impurities are included in Total Dissolved Solid. Upper limit of TDS as 1000 mgL^{-1} specified by World Health Organization in 1993. Higher level of total dissolved solid may cause kidney disease, calcium deposition, stone, etc. Present study shows that TDS comes out to be 400 to 800 mgL^{-1}. Season wise lowest and highest value of this parameter are given below:

Higher value was found for **SAMLOD** station and Lower value was found for **DABHALI** station during winter season.

Higher value was found for **SAMLOD** station and Lower value was found for **BHUVA** station during summer season.

Higher value was found for **SAMLOD** station and Lower value was found for **DABHALI** station during monsoon season.

pH

pH is indicates the acidity and alkalinity of water. Acidic pH range is 0-7 and basic pH range is 7-14. Acceptable pH of water is 6.5-8.5 according to World Health Organization.

Higher value was found for **OSARA** station and Lower value was found for **SEGVA** station during winter season.

Higher value was found for **BAMBUSAR** station and Lower value was found for **SAMLOD** station during summer season.

Higher value was found for **BAMBUSAR** station and Lower value was found for **KARELA** station during monsoon season.

Total Hardness

Water contains anions, salts, minerals and cations such as magnesium and calcium. All these ions are responsible for the hardness of water. Acceptable value of total hardness for potable water is 300 mgL^{-1} according to WHO.

Higher value was found for **SAMLOD** station and Lower value was found for **SHAHPURA** station during winter season.

Higher value was found for **HALDAR** station and Lower value was found for **AMLESHWAR** station during summer season.

Higher value was found for **HALDAR** station and Lower value was found for **AMLESHWAR** station during monsoon season.

Calcium content

Calcium is required to strengthen our bones but excess level of calcium may cause kidney stone and other problems. Desirable limit for calcium is 75 to 200 mgL^{-1} in accordance with WHO.

Higher value was found for **AMLESHWAR** station and Lower value was found for **KARELA** station during winter season.

Higher value was found for **BAMBUSAR** station and Lower value was found for **SAMLOD** station during summer season.

Higher value was found for **BHUVA** station and Lower value was found for **AMLESHWAR** station during monsoon season.

Mg^{2+} content

To keep the digestion better in the body, Magnesium is the one of the important mineral but its values above the desirable value may led to irritation in gastrointestinal tract. Desirable value is 50 to 100 mgL^{-1} according to WHO.

Higher value was found for **BAMBUSAR** station and Lower value was found for **AMLESHWAR** station during winter season.

Higher value was found for **KELOD** station and Lower value was found for **SEGVA** station during summer season.

Higher value was found for **KELOD** station and Lower value was found for **SEGVA** station during monsoon season.

Chloride content

Most of water bodies possess chloride and more than 50% chloride is present in the common salt. Higher level of chloride may cause seance towards test, heart, kidney and laxative effect. Desirable value is up to 250 mgL^{-1} according to WHO.

Higher value was found for **ADOL** station and Lower value was found for **OSARA** station during winter season.

Higher value was found for **AMLESHWAR** station and Lower value was found for **BHUVA** station during summer season.

Higher value was found for **AMLESHWAR** station and Lower value was found for **BHUVA** station during monsoon season.

$SO4^{-2}$ content

As compared to chloride, the sulphate has very slight outcome on the test of water. Higher level of sulphate in comparison to desirable limit may cause intestinal disorder and diarrhea. Desirable value is from 200 to 400 mgL^{-1} according to WHO.

Higher value was found for **ADOL** station and Lower value was found for **OSARA** station during winter season.

Higher value was found for **HALDAR** station and Lower value was found for **BAMBUSAR** station during summer season.

Higher value was found for **HALDAR** station and Lower value was found for **AMDADA** station during monsoon season.

$NO3^{-}$ content

Nitrate is available in combined form such as nitrogen, which is one of the important components for the plant growth. If nitrate containing water is used for preparation of food, it will cause diarrhea in child and adult as well as blue baby syndrome. Desirable value is up to 45 mgL^{-1} according to WHO.

Higher value was found for **AMLESHWAR** station and Lower value was found for **GHODI** station during winter season.

Higher value was found for **GHODI** station and Lower value was found for **AMLESHWAR** station during summer season.

Higher value was found for **GHODI** station and Lower value was found for **AMLESHWAR** station during monsoon season.

Fluoride content

Number of minerals are soluble in water because they form salt with the fluoride. Fluorosis, porous bone disease is caused by the excess limit of the fluoride ion. Desirable value is 0.6 to 1. mgL^{-1} according to WHO.

Higher value was found for **GHODI** station and Lower value was found for **BHUVA** station during winter season.

Higher value was found for **BHUVA** station and Lower value was found for **ADOL** station during summer season.

Higher value was found for **BHUVA** station and Lower value was found for **ADOL** station during monsoon season.

Alkalinity

Water is alkaline because of presence of carbonates, bicarbonates and hydroxides. It is nothing but ability of water to neutralize acidity. Desirable value is up to 600 mgL^{-1} according to WHO.

Higher value was found for **AMDADA** station and Lower value was found for **KARELA** station during winter season.

Higher value was found for **AMLESHWAR** station and Lower value was found for **BHUVA** station during summer season.

Higher value was found for **KARELA** station and Lower value was found for **BHUVA** station during monsoon season.

Turbidity

Desirable value is 10 NTU for drinking water, according to WHO.

Higher value was found for **AMDADA** station and Lower value was found for **SEGVA** station during winter season.

Higher value was found for **SHAHPURA** station and Lower value was found for **BAMBUSAR** station during summer season.

Higher value was found for **HALDAR** station and Lower value was found for **AMLESHWAR** station during monsoon season.

Chemical Oxygen Demand (COD)

It is the oxygen requirement for oxidation. Of organic matter it is one of the significant properties of drinking water. Majority of ground water was dissolve oxygen level 4.2 to 6.0. Desirable limit is 3 mgL^{-1} according to WHO. Water with saturated oxygen gives very pleasant teste. Water with less dissolve oxygen value than desirable limit is fetal for aquatic animals.

Higher value was found for **CHOLAD** station and Lower value was found for **DABHALI** station during winter season.

Higher value was found for **AMDADA** station and Lower value was found for **AMLESHWAR** Station during summer season.

Higher value was found for **AMDADA** station and Lower value was found for **SEGVA** station during monsoon season.

Biological Oxygen Demand (BOD)

It is the Oxygen requirement for the oxidation of organic waste in the water in the presence of bacteria and/or protozoa. High BOD level indicates less dissolved oxygen. Plant kingdom is survived in the water due to nitrate and phosphate salts present in the water. World Health Organization recommends the water having BOD value 30 $mgL-^{1}$.

Higher value was found for **OSARA** station and Lower value was found for **AMLESHWAR** station during winter season.

Higher value was found for **HALDAR** station and Lower value was found for **DABHALI** station during summer season.

Higher value was found for **HALDAR** station and Lower value was found for **BHUVA** station during monsoon season.

Dissolved Oxygen

Higher value was found for **DABHALI** station and Lower value was found for **SHAHPURA** station during winter season.

Higher value was found for **DABHALI** station and Lower value was found for **AMDADA** station during summer season.

Higher value was found for **DABHALI** station and Lower value was found for **AMDADA** station during monsoon season.

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CHAPTER – V

SUMMARY AND CONCLUSION

CONTENTS

5.1 SUMMARY

In the present study, thirty different stations were selected from two taluka such as Ankleshwar and Bharuch, which are as given below:

1. **ANKLESHWAR TALUKA:**

   SARTHAN, TELVA, PILUDRA, UMARWADA, JETALI, PIPROD, AVADAR, PARDI MOKHA, SANGPOR, KOSAMADI, PANOLI, KHAROD, MOTALI, ANDALA AND UTIYADARA

2. **BHARUCH TALUKA:**

   ADOL, AMDADA, AMLESHWAR, BAMBUSAR, BHUVA, CHOLAD, DABHALI, GHODI, HALDAR, KARELA, KELOD, OSARA, SAMLOD, SEGVA AND SHAHPURA

Overall, fourteen physicochemical parameters like pH, TDS, total hardness (TH), Calcium Content, Magnesium Content, Chloride Content, Sulphate, Nitrate, Fluoride, Alkalinity, Turbidity, Chemical oxygen demand (COD), Biological oxygen demand (BOD) and Dissolved oxygen (DO) were studied for the water samples collected from the 30 stations of Ankleshwar and Bharuch Talukas of Bharuch district of Gujarat. These parameters were also investigated in different season's like, winter, summer and monsoon. It was observed that some physicochemical parameters are within the permissible limit and some are deviated from the standard values (as recommended by WHO) at different stations of these two talukas in different seasons.

It was observed that groundwater of these stations is getting polluted due to more than 1000 industrial units present in these talukas. These industrial units are of diverse nature like chemicals, pharmaceuticals, plastics, textiles, dyes, fertilizers, pigments, paints, insecticides, speciality chemicals, synthetic fibres, fibre intermediates, polymers, pesticides, chloromethane, aniline, nitrobenzene, calcium carbide, carbon black titanium dioxide, aluminium fluoride, sodium chlorate, red phosphorous, soda ash, caustic soda, liquid chlorine, etc. The present study indicates that the ground water in Ankleshwar and Bharuch talukas is becoming contaminated due to the various industrial units of diverse range. A huge amount of waste is generated annually by these industries. Effluents from these industrial units, if not properly treated and drained in waterbodies, then people living in villages around this area may be at risk because they are dependent on groundwater for their day to day need of water.

Crops growing on the polluted soil (due to effluent discharge and dumping of wastes) can absorb the pollutants form soil and ultimately that will reach to the food, causing dreaded disease like Cancer and mental illness. Contamination of groundwater in these talukas due to heavy metals is also a serious concern, but few reports are there in in this regard. The contamination of groundwater due to chromium may be linked to pigment and pharmaceutical industries and lead contamination may be associated with fertilizers, paint industries, and also due to the highways (NH8)

5.2 CONCLUSION

The following conclusions were drawn from the present investigation –

1. The present investigation indicates that groundwater quality is deteriorating and as per requirements (of WHO & other agencies), water quality is not completely suitable for drinking purposes.
2. There need further investigations for water quality parameters as we well as for contamination due to heavy metals in the groundwater.
3. Earlier, the industrial units of Ankleshwar, Panoli, Dahej were discharging their effluents in to the river Amlakhadi. This river meets the Narmada river near Bharuch. In 1995, COD of this river water was about 11000 mg L-1(by GPCB), which is much higher than the prescribed Standard value of 250 mg L-1. BOD was also 442 mg L-1, which is far away from standards decided by GPCB (30 mg L-1). Even the GPCB ordered to stop about six Industrial units in this area because of discharging effluents in waterbodies. The present study shows that to prevent further pollution of groundwater, standard protocols for effluents, their treatment and discharge are to be followed strictly. If discharge of effluents and solid waste is not proper, then it will percolate to reach to groundwater and polluting it.
4. So many problems faced by peoples of these are such as cancers, paralysis, neurological, disorder, nerve damage, thyroid problems, liver damage, kidney problems, cardio-vascular disorder finger nail loss, diarrhea, hair loss, mottle teeth,

lung irritation due to drinking poor quality water so it creates scope for proper research to check quality of water.

5. Examination of physicochemical parameters of water collected from Bharuch region with respect to concentration of ions phosphate, chlorides, calcium, Magnesium and Nitrate values, C.O.D, B.OD, total alkalinity, pH, dissolved oxygen (DO) total dissolved solid (T.D.S).

6. In the present investigation, the physicochemical parameters of groundwater of Ankleshwar and Bharuch. talukas were studied in different seasons like, winter, summer and monsoon. So, the indication of variation of parameters in different seasons will provide opportunities to take necessary steps in advance to reduce the pollution before the season arrives. So season wise study is helpful in planning the techniques to be used to reduce a particular type of contamination.

7. The physicochemical parameters for drinking water through a light on its, quality and the present study is important in a way that people living in villages around these industrial area will become aware about the water they have been consuming for their daily needs. Another aspect of the present study is to plan and develop mitigation strategies timely for improving water quality to sustain life.

8. The waterable is continuously going down due to overexploitation of groundwater for daily needs industrial needs and irrigation purposes. There is urgent need to recharge the groundwater using rain harvesting systems and other artificial recharge techniques to raise the water levels. This should be accorded top priority.

9. Flow water may be properly managed to recharge and raise groundwater levels after the monsoon season.

10. The present study will make aware the farmers and villagers around these talukas for quality of groundwater they have been using for different purposes.

11. It is also necessary to reduce the dependency on groundwater, because much extraction of groundwater will decrease the therefore, availability of potable water. Along with groundwater recharge techniques, our traditional sources of water like, wells, step wells rivers, ponds, etc. should not be neglected these should not only be preserved but also to be revitalised.

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PUBLICATIONS

PHYSICO-CHEMICAL PARAMETERS OF GROUND WATER FROM SELECTED AREA OF ANKLESHWAR TALUKA OF BHARUCH DISTRICT-GUJARAT

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ABSTRACT

A various Physico-Chemical parameters like pH, Total hardness, Total dissolve solid (TDS), Total alkalinity, Chloride, Sulphate, Calcium, Magnesium, Nitrate values, Chemical oxygen demand (COD), Biological oxygen demand (BOD), Fluoride and Turbidity are measured and analysed for six stations such as Kosambdi, Andala, Sarthan, Telva, Kharod and Panoli of Ankleshwar Taluka of Bharuch district. All the parameter measurements are performed in terms of three different seasons such as Winter, Summer and Monsoon. Results obtained are compared in terms of their highest value and lowest values among six stations in terms of 13 parameters.

Key Words: Total Dissolved Solid, Ankleshwar, Ground water, COD, BOD, Magnesium content, Turbidity.

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GROUND WATER ANALYSIS OF WATER SAMPLE COLLECTED FROM SELECTED STATIONS OF BHARUCH DISTRICT

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ABSTRACT

A various Physico-Chemical parameters like pH, Total hardness, Total dissolve solid (TDS), Total alkalinity, Chloride, Sulphate, Calcium, Magnesium, Nitrate values, Fluoride and Turbidity are measured and analysed for five stations such as ADOL, AMDADA, AMLESHWAR, BAMBUSAR and BHUVA of Bharuch district. All the parameter measurements are performed in terms of three different seasons such as Winter, Summer and Monsoon. Results obtained are compared in terms of their highest value and lowest values among five stations in terms of 11 parameters.

Keywords: Ground water, Total Dissolved Solid, Bharuch, COD, BOD, Magnesium content, Turbidity

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