TO STUDY THE VARIATION OF GROUNDWATER OF KALAT REGION

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Certification

This is to certify that **Inayat Ullah, 19CE22** and **Abu Bakar Zahoor, 19CE81** have successfully completed the final project **To Study the Variation of Groundwater of Kalat Region**, at the **Balochistan University of Engineering and Technology Khuzdar**, to fulfill the partial requirement of the degree **B.E Civil Engineering**.

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TO STUDY THE VARIATION OF GROUNDWATER OF KALAT REGION

Sustainable Development Goals

(Please tick the relevant SDG(s) linked with FYDP)

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3	Good Health and Well Being ✓	SDG 11	Sustainable Cities and Communities
SDG 4	Quality Education	SDG 12	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13	Climate Change
SDG 6	Clean Water and Sanitation✓	SDG 14	Life Below Water
SDG 7	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals

Range of Complex Problem Solving			
	Attribute	**Complex Problem**	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	✓
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	✓
4	Familiarity of issues	Involve infrequently encountered issues	
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	
7	Consequences	Have significant consequences in a range of contexts.	✓
8	Interdependence	Are high level problems including many component parts or sub-problems	✓
Range of Complex Problem Activities			
	Attribute	**Complex Activities**	
1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	✓
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	✓
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	✓
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	✓

Abstract

Groundwater is a major source of water for living beings. However, with the deepening of the development and utilization of water resources, especially under the serious shortage of fresh water in Pakistan and similar areas of the country, the deterioration of groundwater quality has become a major problem. The aim of present study is to assess the variation of groundwater quality of KALAT region for drinking purpose by using WQI. Randomly four samples were collected from variable depths and water quality were assessed through laboratorial tests of physiochemical parameter including pH, Electron conductivity (EC), Chlorides (Cl), Sulphate (SO_4), Iron (Fe), Arsenic (As), Manganese (Mn), Cadmium (Cd), Lead (Pb). The study revealed that the groundwater of study area physiochemical ranges from minimum value to maximum value has Cl (36-255 mg/l), SO_4 (1.17-283 mg/l), Fe (BDL>0.04 mg/l), As (BDL>0.13 µg/l), Mn (BDL>0.05 mg/l), Cd (0.22-0.27 µg/l), Pb (2.00-2.3 µg/l). The pH of these samples ranges from (6.9-7.5), EC (369-777µs/cm) and TDS (440-820mg/l). The result suggests that the groundwater of study area by using the WQI almost safe for drinking purpose because of its WQI range is 25-110, and water quality is Good while some samples of the study area WQI is above the >100 because of high contents of Cl (255 mg/l) and SO_4 (283 mg/l) as per WHO standards.

Keywords: Groundwater; physiochemical; electron conductivity

Undertaking

I certify that the project **To Study the Variation of Groundwater of Kalat Region** is our own work. The work has not, in whole or in part, been presented elsewhere for assessment. Where material has been used from other sources it has been properly acknowledged/ referred.

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CHAPTER 01

INTRODUCTION

1.1 INTRODUCTION

Groundwater is the water that is stored below the surface of the Earth in the spaces between soil particles, rocks, and in underground aquifers. It is a critical component of the Earth's natural water cycle, and it is a major source of water for humans, plants, and animals. Groundwater is a renewable resource, but its availability and quality are threatened by human activities such as overuse, pollution and climate change.

Groundwater is formed by precipitation and surface water that infiltrates into the soil and rock. It can be found at different depths depending on the geology of the area. The top layer of soil is called the unsaturated zone, where the soil and rock contain both air and water. The saturated zone is the layer below the unsaturated zone, where the soil and rock are completely filled with water.

Aquifers are underground layers of permeable rock, such as sandstone or limestone, that contain groundwater. Aquifers can be confined or unconfined, depending on whether the water is under pressure from an overlying layer of impermeable rock. Confined aquifers are typically deeper and contain older water that has been stored for thousands of years. Unconfined aquifers are closer to the surface and are recharged more quickly.

Groundwater moves slowly through the soil and rock, following the gradient of the land and flowing from areas of high elevation to areas of low elevation. It can also be affected by human activities such as pumping, which can cause water to flow more quickly or in a different direction than it would naturally.

Groundwater is an essential resource for human societies, particularly in areas where surface water is scarce or unreliable. It is used for drinking, irrigation, and industrial purposes. In many parts of the world, groundwater is the primary source of water for agriculture, which accounts for over 70% of global freshwater use.

However, groundwater is also a vulnerable resource that is under threat from overuse, pollution, and climate change. In some areas, groundwater is being pumped out faster than it can be replenished, leading to declining water levels and degraded water quality. Pollution from agricultural, industrial, and urban activities can also contaminate groundwater, making it unsafe for human consumption.

Climate change is also affecting groundwater resources, as changes in precipitation patterns and temperature can alter the amount and timing of water that infiltrates the soil. Rising sea levels and increased flooding can also lead to saltwater intrusion into coastal aquifers, making the water unusable for human consumption.

To manage groundwater sustainably, it is important to understand how much water is available, where it is located, and how it is being used. Groundwater monitoring networks can provide valuable data on water levels and quality, while groundwater models can simulate how water moves through the soil and rock.

Effective management of groundwater also requires collaboration between different stakeholders, including government agencies, water users, and environmental organizations. Solutions to groundwater challenges may include reducing water use through conservation and efficiency measures, improving water quality through better management of pollution sources, and increasing the recharge of aquifers through artificial recharge or land management practices that promote infiltration.

Groundwater is a critical resource that plays a vital role in sustaining ecosystems and human societies. However, it is a vulnerable resource that is threatened by overuse, pollution, and climate change. Effective management of groundwater requires a comprehensive understanding of its availability, location, and use, as well as collaboration between different stakeholders to ensure its sustainability for future generations.

In Pakistan, the symbols of water stress are everywhere in the form of water resources reduction, water scarcity, quality, decrease of level and contamination. Groundwater is an essential natural resource that is widely used for drinking, irrigation, and industrial purposes. However, the quality of groundwater can be impacted by various factors such as human activities, geological processes, and natural contaminants.

Therefore, studying the variation of groundwater quality is essential to assess the suitability of groundwater for different purposes and to develop appropriate strategies to protect this valuable resource.

The study of groundwater quality variation typically involves the collection of groundwater samples from different locations and depths of KALAT region and analyzing them for various chemical and physical, parameters such as pH, total dissolved solids (TDS), EC, Pb, SO4, Cl, As, Mn, and Cd. The collected data can then be used to identify the spatial and temporal variation in groundwater quality and to develop appropriate strategies for managing and protecting groundwater resources.

In the last few years, there have been a lot of studies about groundwater quality in different areas of Pakistan, where a semiarid or arid climate makes water an especially valuable resource. According to available data, 93% of the country's freshwater is used for agriculture. Canals irrigate 70–80% land of Pakistan. Current resources of surface water appear deficient and out of balance in time and distance. A massive groundwater irrigation system in Pakistan's Indus basin has expanded due to changes in storm water runoff. Growers who rely on groundwater for irrigation have dubbed the significant increase in groundwater usages over last half-century a "revolution." The percentage of overall groundwater used for irrigation has increased by over 50% since 1960. Although aquifers are important to agricultural output, groundwater is increasingly scarce in Pakistan. Surface water availability has dropped from 5260 cubic meters per person in 1951 to 1000 cubic meters per person in 2016. It is projected that numbers will decrease to around 860 cubic meters by 2025, indicating that Pakistan is transitioning from "water pressure" to "scarce water". This reduction in surface water likely reduces the rate of replenishment of groundwater, resulting in the depletion of underground aquifers. Climate change is worsening the situation. With rainfall becoming more variable and droughts becoming more common, groundwater has become an increasingly important resource, and the recharge required to replenish aquifers is becoming increasingly insufficient. A changing climate also has an impact on other variables in the hydrologic cycle, such as soil moisture and snowpack, which are affected by rising temperatures and rainfall variance. Groundwater is a valuable natural resource, particularly in rural areas, and should not be neglected because surface water resources are limited in arid and semi-arid regions, therefore, groundwater is important for fulfilling the region's water supply and agricultural needs.

Every year, contaminated drinking water affects approximately 4 million consumers, many of them are children, in developing countries. Issues with groundwater quality are difficult to assess and manage. Groundwater contamination and its source have been studied using a variety of approaches, including septic tank seepage , landfill leachates, residential sewage, agricultural spillover, horticultural fields as well as liquid waste from industrial plants. The impact these sources are on quality of water, significantly differs in gravity changing on the unique geography of a region

1.2 STUDY AREA

This research project will be conducted out at KALAT region and within the KALAT region we collect the groundwater sample of District KALAT and KHUZDAR in BALOCHISTAN, PAKISTAN.

Table 1.1 (a) Latitude, Longitude, Elevation of District KHUZDAR

Latitude DMS:	27°48'43.27"N
Longitude DMS:	66°36'42.09"E
Elevation:	1229.69 Meters (4034.43 Feet)

Table 1.2 (b) Latitude, Longitude, Elevation of District KALAT

Latitude DMS:	28°30'43.27"N
Longitude DMS:	67°29'42.09"E

Elevation:	2007 Meters (6585 Feet)

Figure 1.1: Map of Study Area

1.3 PROBLEM STATEMENT

The purpose of this study is that the groundwater quality of KALAT region effects the human health. This study will assess the physical, and chemical, properties of the groundwater and identify any potential sources of contamination that may affect the quality of the water. This study will also examine the impact of human activities, such as agricultural practices, industrial activities, and domestic sewage, on the groundwater quality in the study area.

1.4 AIMS AND OBJECTIVES

The aim of the present study is to analyze water either it is drinkable or not and objectives of this study area as follows:

- To study the physiochemical characteristics of the groundwater quality of KALAT region.
- To assess the water quality of groundwater using an integrated indexical approach, i.e the Water Quality Index (WQI) model.

- To compare the results of each parameter according to WHO (world health organization) guidelines and standards.

1.5 SCOPE OF THE STUDY/ LINKAGE WITH SUSTAINABLE DEVELOPMENT GOALS

The scope of this study is to provide the clean drinking water to the localities as per the requirements of United Nations Sustainable Developments Goals particularly which deals with clean water and health of living beings.

SDG-3: Good Health and Well-being

SDG-6: Clean Water and sanitation

1.6 OUTCOMES OF THE PROJECT

The outcomes of this study reveals that the groundwater quality of Kalat region is mostly fit for drinking purposes as per the standards.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Groundwater is a major source of water for all living beings. Groundwater is a renewable resource, but its availability and quality are threatened by human activities such as overuse, pollution and climate change.

The literature review focuses on the variation of groundwater quality thus the following literature review are Discuss bellow.

2.2 Various Literature Review

According to a study conducted by Nasim Sohrabi et al. (2014). Human health is strongly influenced by water quality which is threatened by the poor quality of polluted groundwater. In this study, the groundwater quality and its suitability for drinking have been studied in Lenjanat plain aquifer, Iran. Fifty-nine groundwater samples from study area were evaluated based on WHO and Iranian standards for drinking water. Groundwater samples from selected monitoring sources were sampled seasonally during 2009–2010. Physical and chemical parameters of groundwater such as electrical conductivity, pH, total dissolved solids, Ca2?, Na?, K?, Mg2?, HCO3 -, SO4 2-, Cl-, F- and NO3 - were determined. During the water quality index calculating process, the weight of each parameter is usually given by experts according to their practical experience, which is subjective, so much useful and valuable information about the water quality gets lost. In order to avoid personal judgments about the weight of parameters, an information entropy method was used to assign weight to each parameter. Calculation of entropy weighted water quality index (EWQI) for groundwater samples showed that in the wet season, over 57 and 74 % of samples were in the range of ‘‘excellent’’ to ‘‘medium’’ quality based on WHO and Iranian standards, respectively. Due to groundwater quality reduction during dry season, 42 and 62 % of samples were in the range of ‘‘excellent’’ to ‘‘medium’’ quality based on WHO and Iranian standards, respectively. The results indicate that application of the EWQI is decision-makers will be able to identify and to evaluate groundwater quality in Lenjanat, Iran.

According to a study conducted by A. Logeshkumaran et al. (2014). In the present study, the geochemical characteristics of groundwater and drinking water quality has been studied. 24 groundwater samples were collected and analyzed for pH, electrical conductivity, total dissolved solids, carbonate, bicarbonate, chloride, sulphate, nitrate, calcium, magnesium, sodium, potassium and total hardness. The results were evaluated and compared with WHO and BIS water quality standards. The studied results reveal that the groundwater is fresh to brackish and moderately high to hard in nature. Na and Cl are dominant ions among cations and anions. Chloride, calcium and magnesium ions are within the allowable limit except few samples. According to Gibbs diagram, the predominant samples fall in the rock–water interaction dominance and evaporation dominance field. The piper tri linear diagram shows that groundwater samples are Na–Cl and mixed CaMgCl type. Based on the WQI results majority of the samples are falling under excellent to good category and suitable for drinking water purposes.

According to a study conducted by Aysen Davraz et al. (2015) Groundwater is a vital source of water for domestic and agricultural activities in the Tefenni plain. Therefore, groundwater quality, seasonal variations and its suitability for drinking, irrigation and industrial usage were evaluated. In this study, 56 water samples were collected from springs, wells, and lake in dry and wet seasons. Ca– Mg–HCO3, Mg–Ca–HCO3, Na–CO3–Cl, and Na–HCO3– Cl water types are the dominant water types in the investigation area. Parameters, which are controlled to chemical variations of groundwater, were analyzed with R-mode factor and correlation analysis. According to R-mode factor analysis, total dissolved solids, Na, Cl, HCO3, and NH3 are the most important parameters. In addition, Water Quality Index (WQI) was applied to suitability for drinking purpose and to investigation of groundwater quality. Quality of groundwater are suitable for drinkable both dry and wet season in study area. In terms of the irrigation and Industrial usage, generally groundwater is suitable in dry season but is not suitable in wet season. Groundwater chemistry is affected with water–rock interaction and densely agricultural activities.

According to a study conducted by Hui et al. (2020), the impact of human agricultural production, climate and environmental changes on groundwater for drinking purpose in Hailun during the span of time June to October 2019.Total 77 samples from shallow and 57 samples from deep groundwater were analysed on Correlation Analysis (CA) and Durov Diagram. The study concluded that groundwater resources in Hailun are clean and suitable for drinking. The study was conducted on samples using two standard numerical models and geospatial techniques. The results highlighted that groundwater of most areas do not meet WHO guidelines and use of that water is of high risk for human health.

According to a study conducted by Mansour et al., (2017), water quality must be assessed because it contains heavy metalloids and hazardous chemicals. The major goal of this study was to achieve the appropriate quantity of heavy metals concentration in drinkable water in the city of Khorramabad, therefore according to the research, 45 sites were pinned from which sampling was done, and the findings showed the number of metals present, such as Pb, Cr, Cd, Cu, and Zn were 3.2 ug/l, 5.08 ug/1,0.42 ug/1, 6.79 mg/l and 47.01 mg/l, For elements such as Zn, Pb, Cd, Cu, and Cr, water quality indices such as HEI and HPI were analyzed with the findings averaging 46.59. As a result of these numbers, we may state that the city of Khorramabad is in a good state when talking about heavy metals.

According to the study conducted by S.H. Ewaid and S.A. Abed (2017) Biological oxygen demand (BOD), hydrogen ion concentration, dissolved-oxygen, TDS, nitrates, phosphates, chlorides, TH, electrical conductivity, and alkalinity were all used to assess the Al-Gharrif river. Samples were collected every month from 5 different stations between 2015 and 2016, and studies were limited to 11 parameters on which analysis was done. When turbidity was not taken into account, the number one station was found to be good for drinking, while the number two, three, and four stations were found to be bad, and station five was completely unfit for drinking. When turbidity was taken into account, the index showed that the river water was unfit for drinking. This study demonstrates the importance of water quality indices in determining the quality of water and in interpreting the information for local people in order to ensure that the water quality is safe to consume.

According to the study conducted by Solangi et al., (2018) The water quality changes with changing weather and climatic circumstances; the study focused on the Indus Delta in Pakistan, where the water was found to be physically unfit due to seawater intrusion, and residents of the area relied on it for their daily requirements. The purpose of the study was to examine the water quality of surface water using a different mathematical Model as Water Quality Index (WQI) and Synthetic Pollution Index (SPI) were used to analyze physicochemical characteristics from roughly 50 samples collected from river lakes, ponds, and depressed zones. According to the WQI index, 82 percent of the water is unfit for drinking and agricultural use, while the remaining 18 percent is found to be of very poor quality. According to the SPI index, water quality is 2 percent moderately polluted and 20 percent severely polluted, with 78 percent unfit for drinking. This study demonstrates how critical it is to employ WQI models for quality evaluation in order to enhance our health.

According to the study conducted by Zhaoshiet al. (2017) Prom January 2009 to October 2014, twenty-four samples were taken every three months from 15 different sites in Lake Poyang, and the water quality was assessed for about 20 parameters, including toxic and casily treatable metals. The results obtained by using the water quality index model indicate that the water quality in Lake Poyang is "moderate," according to Chinese standards, Other harmful metals in Lake Poyang were mainly at a safer Icvcl for drinking purposes, while treatable characteristics such as Total Phosphorous (TP) and Total Nitrogen (TN) mostly decide the WQI value in the assessment of tests. The local governments should pay attention to the nutrient concentration since it indicates that the water is of poor quality, particularly when the water level is low, as it was in Lake Poyang.

According to the study conducted by S. Zahedi (2017), groundwater is important in arid or semi-arid areas such as in the Karaj plain, Iran, since Groundwater resources are the longest-serving alternatives to provide water for agricultural irrigation, drinking, and industrial reasons. But in many agricultural regions as mentioned above the usage of groundwater is for both purposes such as drinking and agriculture but the assessments of the water are seriously low or limited, and mostly the wells being shared for the drinking use are nearby to the agricultural lands which mainly impact on the quality due to contaminants and pesticides were being present in the agriculture lands, in this study two models were introduced and used in the research named. Drinking water quality index (DWQI) and Irrigation water quality index (IWQI).

According to the study conducted by Zhibong et al., (2018) The country of Namibia is known as a dry country in the southern African region, so groundwater is known to be the most important role-player in development; in some regions, such as the northwest part, groundwater is not used for drinking due to its poor quality, so it is very important to determine the quality and hydro-geochemical process for proper groundwater usage; in this study, the regions considered were Cuvelai-Etosha Basic as well as the Cuvelai- Etosha Basic. Since the results and observations suggest that the groundwater from precipitation was unaccepted in terms of colour and tastes, but may be safe for human consumption, the sample amount was taken as 24 for the testing, and the model used for water quality evaluation was single factor index technique. The saline qualities of water were not meeting WHO requirements due to increased salinity, which was mostly due to mineral dissolution of carbonates, and the total dissolved solutes (TDS) ranges were low in the Cuvelai-Etosha Basin and Kaokoveld region.

According to the study conducted by S. H. Ewaid (2016), The National Sanitation Foundations Water Quality Index (NFSWQI) and Heavy Metal Pollution Index (HMPI) were used to determine the quality of water in the Al-Gharraf river basin in the Tigris River south of Iraq, which are based on 13 chemical, physical, and biological parameters of water quality. The NSFWQI ranges from 62 to 70, indicating that the water is of medium quality. and the value of HPI were obtained as 98.7 The water quality in the upper-stream was found to be better than the water quality in the down-stream due to fewer water and toxins present alongside This study emphasises the significance of water quality indicators, which demonstrate the significant impact of environmental factors that cause water pollution at the surface level.

According to the study conducted by Egbueri and Unigwe (2019), Because of rapid changes in weather, trade, industry, and urbanisation, the water quality of many shallow coastal aquifers in many parts of the world is under major metals contamination risks. Three water quality fact models and hierarchical cluster analysis (HCA) were combined in the current study to examine significant metals contamination and drinking quality of groundwater in the Oshodi-Isolo arca (Nigeria). Numerous groundwater samples were tested for pH and elite hazardous elements such as Zn, Pb, Cu, Ni, Cr, Mn, and Cd. The pH values ranged from 5.1 to 6.9, with approximately 71.43 percent of the groundwater samples indicating a slightly acidic character. Cu contamination was found in almost eighty percent of the samples tested for hazardous metals. The water quality analysis models, on the other hand, discovered that the majority of the water samples were safe to drink According to the groundwater contamination index, 80.95 percent of the samples exhibit minor pollution. In addition, both a synthetic pollution index and an overall pollution index are available. Classified 85% percent of the samples were classed as lovely water that could be consumed.

The HCA was known for resolving inconsistencies in model outputs. During this investigation, the HCA was supported by two major water quality categories (good water and polluted water). As a result, it is recommended that the polluted water be treated before being consumed by human.

The study conducted by Abbasnia et al., (2018) The study assesses the quality of groundwater for drinking and agricultural purposes, as well as the chemical scientific properties of groundwater in Persia's Sistan and Balochistan province. 654 open wells were sampled, chemical data were evaluated, and a water quality index was calculated to investigate the water quality. To determine water suitability for industrial functions, the Langelier saturation index (LSI), Ryznar Stability Index (RSI), Puckorius scaling index (PSI), Larson-Skold index (LS), and Aggressiveness index (AI) were considered. Finally, using the geographic information system (GIS) setting, the analytical results were used to obtain the numerical spatial distribution of the parameters.

According to the findings, water sources that supported Al and PSI, low and light- weight corrosion according to RSI, and corrosion according to the Larsson-Sckold index were less corrosive. According to the results of the drinkable quality index, 1.2 percent of shared extraction wells were categorized as magnificent, 52.1 percent as good, 39% as terrible, 6% as extremely awful, and 1.7 percent as unfit for drinking purposes. In addition, irrigating the water quality index revealed that 19.9% and 80.1 percent of wells, respectively, were classified as "excellent" and "good." In addition, the water used in this investigation was classed as brackish.

According to the study conducted by Arulbalaji and Gurugnanam (2016) A water quality study was conducted in the Salem district of Tamil Nadu to analyze the water quality for domestic and irrigation purposes. 59 groundwater samples were taken for this study, and pH, electrical conduction (EC), total dissolved solids (TDS), main anions (HCO3, CO3-, F-, Cl-, NO2, NO3, and S04), major cations (Ca, Mg, Na, and K), alkalinity (ALK), and hardness were all measured (HAR). The following chemical parameters, such as the Piper plot, water quality index (WQD), Na surface assimilation quantitative relation (SAR), magnesium hazard (MH), Kelly index (KI), and residual sodium carbonate, were derived based on the analytical data to assess the water quality (RSC). According to the Wilcox diagram, 23% of the samples are glorious to sensible, 40% of the samples are sensible to permissible, 100% of the samples are permissible to uncertain, 100% of the samples are permissible to uncertain, pure gold of the samples are uncertain unsuitable, and only three-dimensional of the samples are unsuitable for irrigation. Fifty-two of the samples have SAR values that suggest high-to-very high alkali water and low-to-medium alkali water. The KI levels show whether the water is of acceptable quality (30%) or not (70%) for irrigation purposes. RSC findings suggest that eighty-nine percent of samples are suitable for irrigation purposes. MH indicates that Revolutionary

Organization 17 November appropriate and eighty- three samples aren't suited for irrigation and domestic functions, with the excellent (8%), good (48%), and poor (48%), respectively (44 percent). Poor water quality is caused by agricultural waste, plant food used, soil activity, urban runoff, farm animal waste, and sewage. Because of their high salinity, hardness, and magnesium content, some samples aren't suitable for irrigation. In general, the groundwater of the Salem district was impure by agricultural activities, anthropogenic activities, natural action, and weathering.

According to the study conducted by Bouteraa et al. (2019), The statistical technique, geostatistical modelling, WQI, and geochemical modelling were used to process the analytical information set of twenty-six groundwater samples from the deposit formation of Boumerzoug-El Khroub vale at the same time. Cluster analysis identifies three main water types that support the main particle contents, with mineralization increasing from cluster one to cluster three. Groundwater quality is influenced by geochemical processes (water-rock interaction) and human follow-up, as these teams were proven by FA/PCA (irrigation). For all hydro-chemical parameter values and WQI, the exponential semivariogram model fit best. The international organization, Ca, K, HCO3, and SO4 have a strong abstraction structure, while Mg, Na, Cl, and NO3 have a moderate abstraction structure. According to the HCA and PCA values, water quality maps were constructed using the exploitation standard Kriging area unit. All water groups are saturated with carbonate minerals, and mineral and Ca- smectite dissolution is one of the processes responsible for hydrochemical evolution in the space.

According to a study conducted by Rabeiy (2018), in dry nations like Egypt, further population expansion and development would require additional water for drinking, irrigation, and residential use. The standard of groundwater is an important study to ensure that it is fit for diverse purposes. 812 groundwater samples were taken inside the territorial division's core space for this study to determine the quality of groundwater for drinking and irrigation. Eleven water parameters were analyzed at every groundwater to take advantage of them in water quality analysis (Na+,K+, Ca2+, Mg2, HCO3 SO4 2. Pe24, Mn2+, CI, electrical physical phenomena, and pH). To examine the distribution of chemical science parameters within the investigated space, traditional statistics were applied to the data. The relationship between groundwater parameters was investigated using the coefficient of correlation, and it was discovered that several water parameters, such as Ca2+ and CI, have a strong association. Water quality index (WQI) is a mathematical model that combines various water factors into a single indicator price that measures the level of water quality. Wol findings revealed that two-hundredths of groundwater samples are excellent, seventy-five percent are good for drinking, and seven are bad water, with only one square of the sample measuring unsuitable for drinking. Three indices are used to check the quality of groundwater for irrigation: atomic number 11 sorption ration (SAR), atomic number 11 proportion (Na percent), and permeableness index (PI).

According to the study conducted by Sener et al., (2017) The study's goal is to assess the water quality of the Aksu watercourse, which feeds the Karacaören-1 Dam Lake and flows for about 145 kilometres from Isparta province to the Mediterranean. This study is important because it was set up to get drinking water from the Karacaören-1 Dam Lake for Adalia Province. Physical and chemical studies of water samples collected from twenty-one places in October 2011 and March 2012, two periods) throughout the watercourse's flow path were explored during this investigation. The results of the analysis were compared to the World Health Organization's most permissible limit values and Turkish drinkable standards. The water quality index (WQI) method was used to assess the water quality for drinking purposes. Within the study, the computed WQI values range from 35 to 35. Karacaören- 1 Dam Lake has generally good water quality, according to the WQI map. Water quality, on the other hand, is poor to extremely bad in the north and south of the geographical area. Water quality in these areas is dominated by the effects of both immediate and diffuse contaminants. Furthermore, the most effective water quality criteria are located in the area unit COD and Mgon the determination of WQI for this study.

According to the study conducted by Baba et al., (2020), Contamination of groundwater could be a significant problem in the area. The purpose of this research is to look at the groundwater quality in the Dier al-Balah Governorate. In the Gregorian calendar months of 2009 and 2014, water samples were collected from nineteen municipal wells and examined for physio-chemical parameters (PH, TDS, Ca2+, Mg2+, Na+, K+, CI, SO42-,HCO3 and NO3). Using the water quality index (WQI) methodology and geostatistical analysis, the analysis seeks to determine groundwater quality and create groundwater quality maps. Because of the infiltration of Mediterranean seawater into the coastal formation, each water sample is saline, according to the findings. Chemical composition changes between 2009 and 2014 suggest that a lot of seawater was combined with the groundwater during the I Chronicles period. The bulk of the determined chemical parameters of all wells are well higher than the WHO water quality standards and every one WQI values indicate that the water quality is problematic. The spatial variation of the WQI scores is modeled by a settled part expressing a linear dependence on the space to the outline associated with a random residual delineate by an exponential variogram with a sensible vary of 3000 m. Regression-kriging is used to map the WQI scores to the resulting water quality categories. The findings show that the groundwater in a large area on the map is unfit for human consumption, and a comparison of the maps from 2009 and 2014 shows that this region has grown by 700 metres upcountry in just five years. Although the findings of this study are alarming, they also contribute to a better understanding of the factors that influence groundwater quality and may aid authorities and stakeholders in property development.

According to the study conducted by Kumar and James (2012), the Groundwater quality of the Tirupur district in Madras was investigated during this study to develop a Water Quality Index (WQI) model. Hydro-chemical parameters showed a tremendous variation of inbound location over the seasons. Textile industries and rock-water interaction are major threats to water quality, according to the ionic chemistry of groundwater. Analysis of sodium and Ca concentration indicates that direct likewise because the inverse ion-exchange controls the natural ion chemistry. The presence of No3 in the pre-monsoon samples indicates that fertilizer use in agricultural fields had harmed them. Except for a few spots, the Na- CI kind of water was prevalent across the study area. According to the WQI, fifty-five percent of pre-monsoon samples and forty-seven percent of post-monsoon samples were classed as poor/very poor/unfit for drinking standard. Throughout the post- monsoon season, the activity of textile waste and its transfer to the downstream were closely monitored. The hydrochemistry of the samples revealed the specific contribution of watercourse Noyyal to the transport of solutes to the discharge zones.

According to the study conducted by Saeedi et al., (2009), Any water quality monitoring study's main goal is to examine the water quality standing for special use. The water quality index (WOI) is a mathematical tool that does not require reworking vast amounts of water quality data into a single range that indicates the water quality level. Developing Wol in a community might be a simple way to start thinking about land use and water resource management. In this study, a simple methodology supported statistical approach is established to create a groundwater quality index (GWOI) to identify sites in the Qazvin Province, west-central Asia, with the best drinking water quality. The approach is based on the calculation of the GWQI based on the average price of eight ion and ion parameters for 163 wells during a three-year period. The normalized price of each parameter in observant wells is used to calculate the fraction of determined concentrations to the maximum permissible concentration. The weight of each parameter is taken into account when calculating the final indices for each well. The resulting indicators are compared to those of well-known mineral waters to determine the groundwater quality of the research area. The indices on the subject of mineral waters were drawn on a map of area.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In order to examine the physiochemical properties of water of KALAT region so the following test were performed.

3.2 Physiochemical parameter

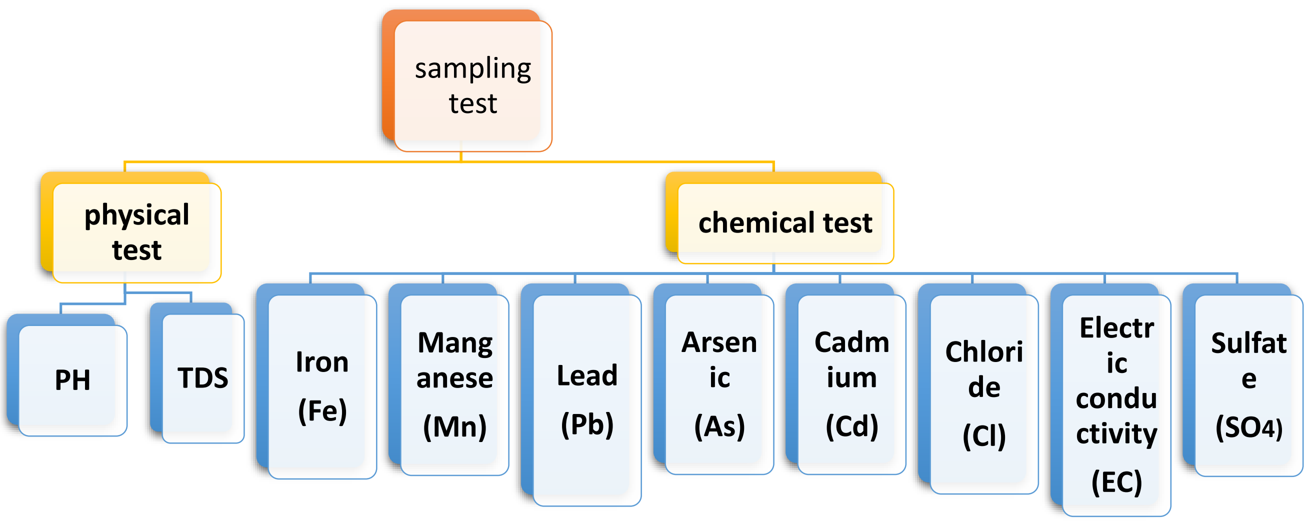

Figure 3.1 flow chart of physiochemical parameters

3.3 This study was carried out into following steps

1. Site selection
2. Groundwater sampling
3. Laboratory analysis
4. Data analysis
5. Communication of result

3.3.1 Site selection

Identify the study area means KALAT region and select the site for ground water.

3.3.1.1 **Geological and Hydrogeological Characteristics:** Study the geological formations in the area, including rock types, sediment layers, and aquifer properties depth to water table.

3.3.1.2 **Water Quality:** Evaluate the quality of groundwater in the region by conducting water quality testing. Identify any potential sources of contamination, such as industrial activities, agriculture, or natural mineral deposits.

3.3.6 Groundwater sampling

We will collect simple from KALAT Region means total samples are four (4), selected sites using appropriate techniques and Equipment. The frequency and number of samples will depend on the study objectives and the variability of groundwater quality over time. In the groundwater sampling phase of our study, we adopted a systematic approach to ensure comprehensive data collection from the KALAT Region. A total of 16 samples were collected from KALAT region. Our selection of sampling sites was based on the utilization of appropriate techniques and equipment, adhering to established best practices in hydrogeology.

The frequency and number of samples were thoughtfully determined, considering the specific objectives of our study and the inherent variability in groundwater quality over time. This approach allowed us to capture a representative snapshot of the region's groundwater quality, providing a solid foundation for our subsequent laboratory analyses and in-depth investigation into the factors affecting water quality in the area.

3.3.3 Laboratory analysis

Conduct laboratory of the analysis collected groundwater samples to Determine their physiochemical properties. Through this extensive analysis, I aimed to gain a holistic understanding of the groundwater's composition and quality, which is crucial for assessing its suitability for various uses and identifying potential environmental concerns.

3.3.4 Data analysis

Analyze the data obtained from the laboratory analysis to identify trends in groundwater quality overtime, spatial variability and potential sources of contamination. In my thesis, I meticulously analyzed the data acquired from laboratory analysis to discern temporal trends in groundwater quality over time, spatial variations across the study area, and potential sources of contamination. By employing advanced statistical techniques and spatial mapping, I uncovered meaningful patterns, helping to elucidate the dynamic nature of groundwater quality and pinpoint areas of concern. This research contributes valuable insights for sustainable groundwater management and underscores the importance of addressing contamination sources to safeguard this vital resource.

3.3.5 Communication of result

Communicate the results of the study to relevant stakeholder, such as water resource manager, policymakers and the public. This may involve publishing research papers presenting results at conference or providing reports to government agencies.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

Physiochemical parameters of collected water are summarized in the following tables and grapes.

Table 4.1(a): Detail result of Sample 1 of the Study Area

Location of sample	CHAMROK, District KHUZDAR	**Humidity (%) at Receipt**	57
Temperature of sample	20		
Sampling receipt date &time	25-7-2023 02:07	**Date(s) of Analysis**	25-07-2023 to 06-09-2023

Table 4.1 (b): Detail result of Sample 1 of the Study Area							
Major Chemical parameters							
Sr. #	Water Quality Parameters	Units	Detection Limit	Reference Methods	Permissible limits/Tolerance limit Potable Water (PSQCA/NSDWQ,2010)	Results	Measurement Uncertainty U=w
1	Chlorides *	mg/L	2.0	APHA, 23rd Edition	<250	255.00	+_5%
2	Sulphate	mg/L	0.28	APHA, 23rd Edition	NGVS	283.00	+_4%
Trace & Ultra-Trace Elements							

Sr. #	Water Quality Parameters	Units	Detection Limit	Reference Methods	Permissible limits/Tolerance limit Potable Water (PSQCA/NSDWQ,2010	Results	Measurement Uncertainty U=w
3	Iron*	mg/L	0.04	APHA, 23rd Edition	0.3(WHO)	BDL	-
4	Arsenic	µg/L	0.13	APHA, 23rd Edition	<50	BDL	-
5	Manganese	mg/L	0.05	APHA, 23rd Edition	<0.5	BDL	-
6	Lead*	µg/L	0.25	APHA, 23rd Edition	<50	2.30	-
7	Cadmium*	µg/L	0.08	APHA, 23rd Edition	10	0.27	-
8	pH	-	-	Ph digital meter	6.5-8.5	6.9	
9	EC	µS/cm	-	EC digital meter	<400	777	-
10	TDS	mg/l	-	TDS meter	300-600	820	

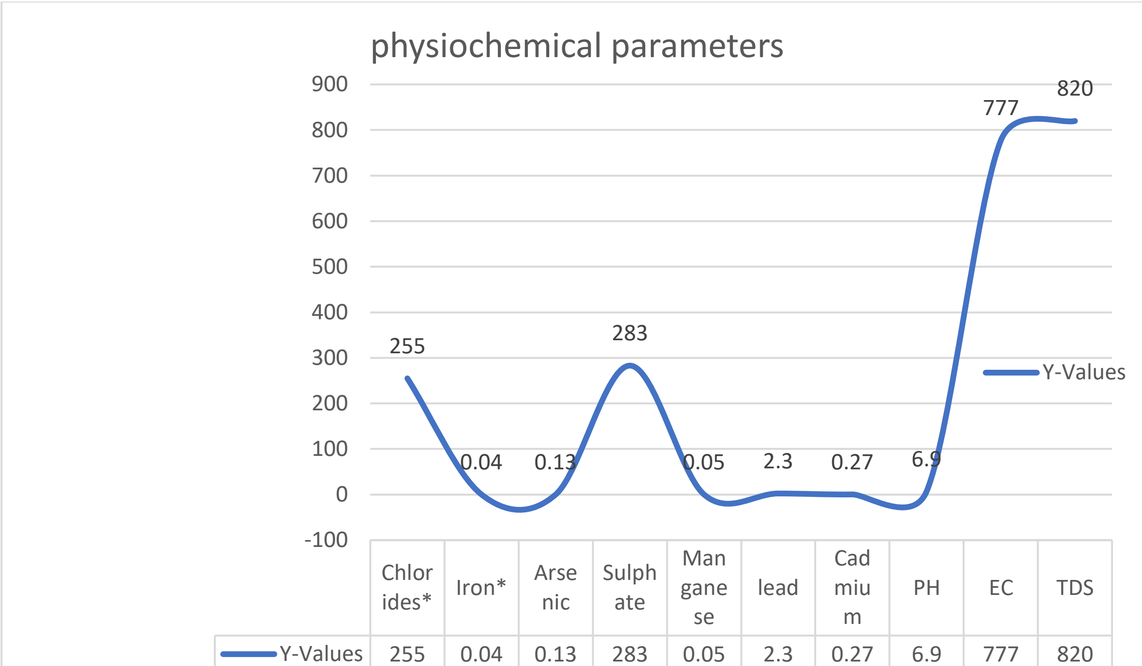

Figure 4.1 The various physiochemical parameters of water sample-1

Interpretation/Statement of Conformity		
Quality of water sample based on tested chemical parameter	**Safe**	✓ **Unsafe**
Remarks(if any)		

Table 4.2 (a): Detail result of Sample 2 of the Study Area

Location of sample	KALAT	**Humidity (%) at Receipt**	57
Temperature of sample	20		
Sampling receipt date &time	25-7-2023 02:07	**Date(s) of Analysis**	25-07-2023 to 06-09-2023

Table 4.2 (b): Detail result of Sample 2 of the Study Area

Major Chemical parameters							
Sr. #	Water Quality Parameters	Units	Detection Limit	Reference Methods	Permissible limits/Tolerance limit Potable Water (PSQCA/NSDWQ,2010)	Results	Measurement Uncertainty U=w
1	Chlorides *	mg/L	2.0	APHA, 23rd Edition	<250	36.00	+_5%
2	Sulphate	mg/L	0.28	APHA, 23rd Edition	NGVS	1.71	+_4%
Trace & Ultra-Trace Elements							
Sr. #	Water Quality Parameters	Units	Detection Limit	Reference Methods	Permissible limits/Tolerance limit Potable Water (PSQCA/NSDWQ,2010	Results	Measurement Uncertainty U=w
3	Iron*	mg/L	0.04	APHA, 23rd Edition	0.3(WHO)	BDL	-
4	Arsenic	µg/L	0.13	APHA, 23rd Edition	<50	BDL	-
5	Manganese	mg/L	0.05	APHA, 23rd Edition	<0.5	BDL	-

6	Lead*	µg/L	0.25	APHA, 23rd Edition	<50	2.0	-
7	Cadmium *	µg/L	0.08	APHA, 23rd Edition	10	0.27	-
8	pH	-	-	Ph digital meter	6.5-8.5	7.2	-
9	EC	µS/cm	-	EC digital meter	<400	651	-
10	TDS	mg/l	-	TDS meter	300-600	720	-

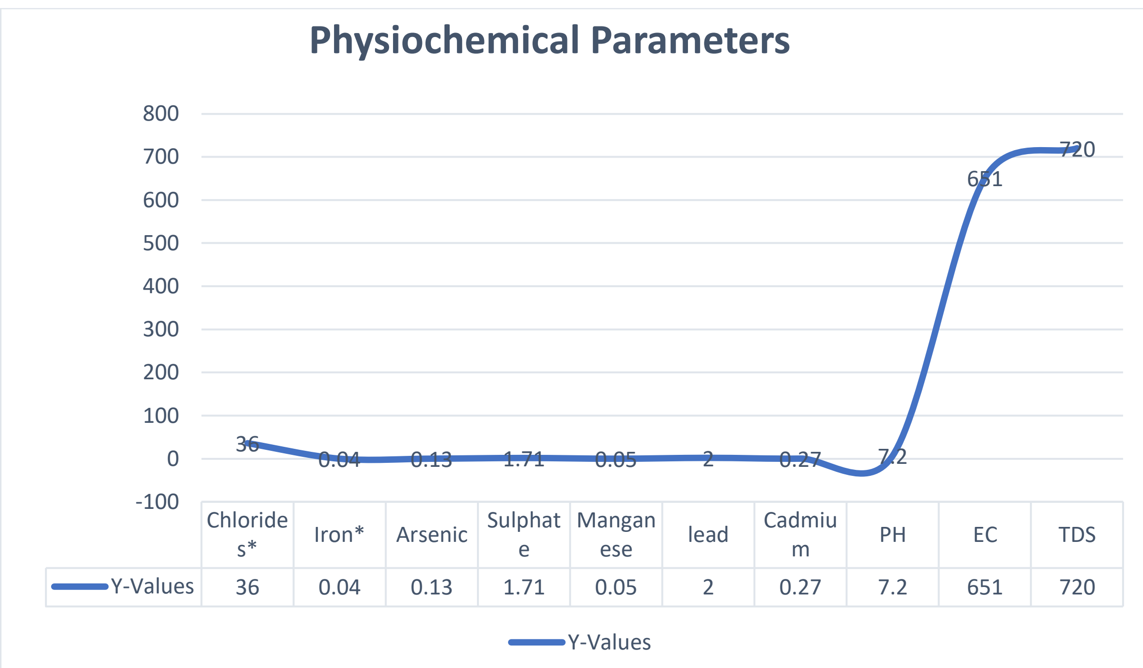

Figure 4.2 The various physiochemical parameters of water sample-2

Interpretation/Statement of Conformity		
Quality of water sample based on tested chemical parameter	✓ **Safe**	**Unsafe**
Remarks(if any)		

Table 4.3 (a): Detail result of Sample 3 of the Study Area

Location of sample	BAGHBANA, district KHUZDAR	**Humidity (%) at Receipt**	57
Temperature of sample	20		
Sampling receipt date &time	25-7-2023 02:07	**Date(s) of Analysis**	25-07-2023 to 06-09-2023

Table 4.3 (b): Detail result of Sample 3 of the Study Area

Major Chemical parameters							
Sr. #	Water Quality Parameters	Units	Detection Limit	Reference Methods	Permissible limits/Tolerance limit Potable Water (PSQCA/NSDWQ,2010)	Results	Measurement Uncertainty U=w
1	Chlorides *	mg/L	2.0	APHA, 23rd Edition	<250	164.00	+_5%
2	Sulphate	mg/L	0.28	APHA, 23rd Edition	NGVS	339.00	+_4%
Trace & Ultra-Trace Elements							

Sr. #	Water Quality Parameters	Units	Detection Limit	Reference Methods	Permissible limits/Tolerance limit Potable Water (PSQCA/NSDWQ,2010	Results	Measurement Uncertainty U=w
3	Iron*	mg/L	0.04	APHA, 23rd Edition	0.3(WHO)	BDL	-
4	Arsenic	µg/L	0.13	APHA, 23rd Edition	<50	6.38	-
5	Manganese	mg/L	0.05	APHA, 23rd Edition	<0.5	BDL	-
6	Lead*	µg/L	0.25	APHA, 23rd Edition	<50	BDL	-
7	Cadmium*	µg/L	0.08	APHA, 23rd Edition	10	0.18	-
8	Ph	-	-	Ph digital meter	6.5-8.5	7.4	-
9	EC	µS/cm	-	EC digital meter	<400	702	-
10	TDS	mg/l	-	TDS meter	300-600	806	-

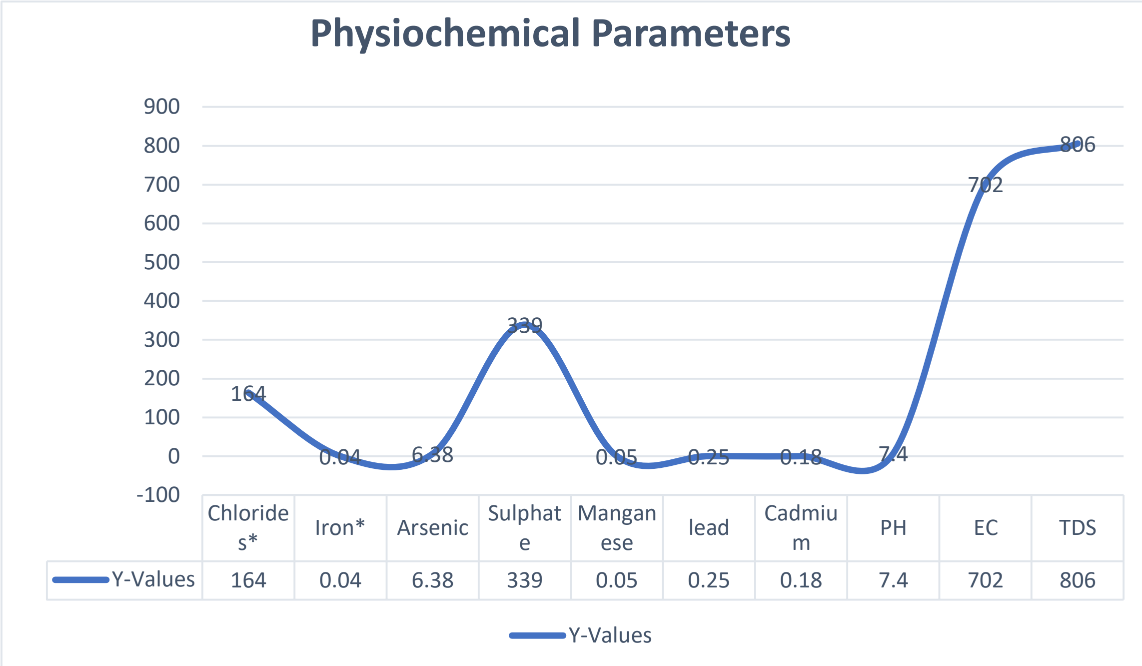

Figure 4.3 The various physiochemical parameters of water sample-3

Interpretation/Statement of Conformity		
Quality of water sample based on tested chemical parameter	✓ **Safe**	**Unsafe**
Remarks(if any)		

Table 4.4 (a): Detail result of Sample 4 of the Study Area

Location of sample	SHAZAD CITY, District KHUZDAR	**Humidity (%) at Receipt**	57
Temperature of sample	20		
Sampling receipt date &time	25-7-2023 02:07	**Date(s) of Analysis**	25-07-2023 to 06-09-2023

Table 4.4 (b): Detail result of Sample 4 of the Study Area

Major Chemical parameters							
Sr. #	Water Quality Parameters	Units	Detection Limit	Reference Methods	Permissible limits/Tolerance limit Potable Water (PSQCA/NSDWQ,2010)	Results	Measurement Uncertainty U=w
1	Chlorides *	mg/L	2.0	APHA, 23rd Edition	<250	48.00	+_5%
2	Sulphate	mg/L	0.28	APHA, 23rd Edition	NGVS	106.00	+_4%
Trace & Ultra-Trace Elements							
Sr. #	Water Quality Parameters	Units	Detection Limit	Reference Methods	Permissible limits/Tolerance limit Potable Water (PSQCA/NSDWQ,2010	Results	Measurement Uncertainty U=w
3	Iron*	mg/L	0.04	APHA, 23rd Edition	0.3(WHO)	BDL	-
4	Arsenic	µg/L	0.13	APHA, 23rd Edition	<50	BDL	-
5	Manganese	mg/L	0.05	APHA, 23rd Edition	<0.5	BDL	-

6	Lead*	µg/L	0.25	APHA, 23rd Edition	<50	BDL	-
7	Cadmium *	µg/L	0.08	APHA, 23rd Edition	10	0.22	-
8	pH	-	-	Ph digital meter	6.5-8.5	7.5	
9	EC	µS/cm	-	EC digital meter	<400	369	
10	TDS	mg/l	-	TDS meter	300-600	440	

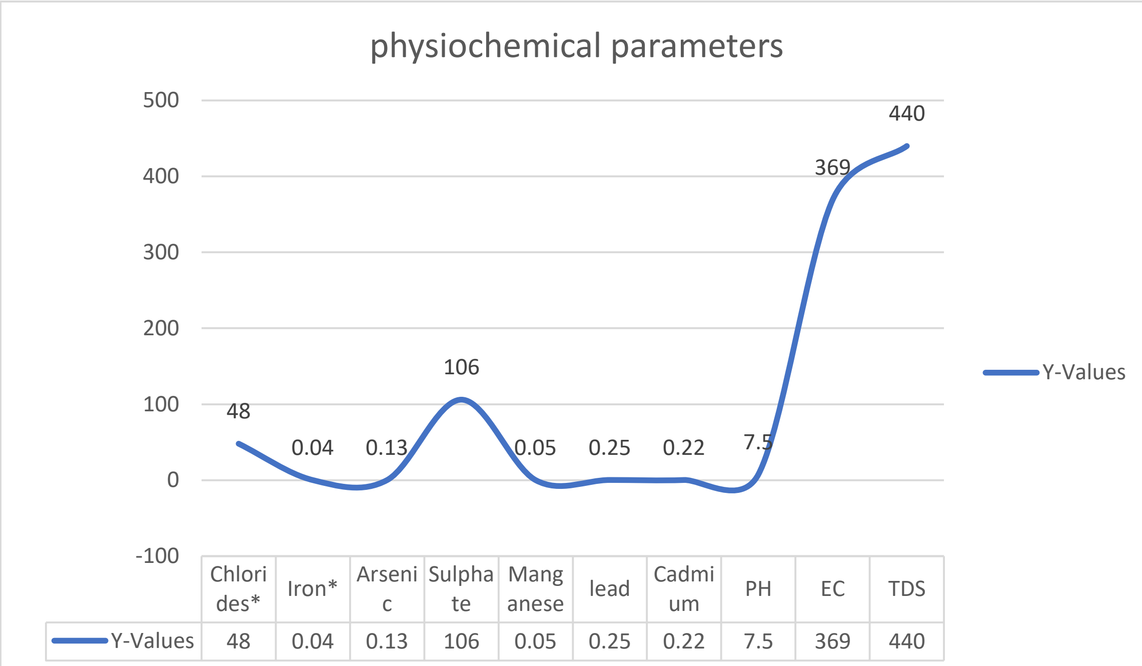

Figure 4.4 The various physiochemical parameters of water sample-4

Interpretation/Statement of Conformity		
Quality of water sample based on tested chemical parameter	✓ **Safe**	**Unsafe**
Remarks(if any)		

4.2 GROUND WATER QUALITY VARIATION

4.2.1 Concentration of pH

The overall pH values at all four locations are shown in tables [4.1 (b), 4.2 (b),4.3 (b),4.4 (b)] and figure [4.1,4.2,4.3,4.4]. World Health Organization (WHO) proposed standard of pH concentration in drinking is 6.5 to 8.5.

Figure 4.5 (a) PH digital meter

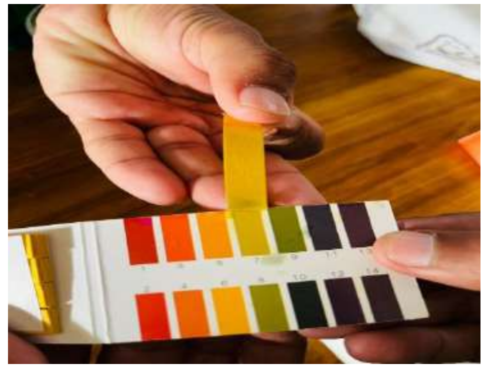

Figure 4.5 (b) PH paper

It shows that all four points result were in limit as compared to WHO desirable standard.

4.2.2 Concentration of EC

Electric Conductivity indicates the concentration of substances in water in the form of ions. The detailed results of EC are revealed in tables [4.1(b), 4.2(b),4.3(b),4.4(b)] and figures [4.1,4.2,4.3,4.4]. WHO desirable limit of EC is 1000 µS/cm for drinking water. EC concentration varies from place to place in the study area with minimum value of 369 µS/cm at SHAZAD CITY and maximum value of 777 µS/cm at CHAMROK. In the study area, the water sample of SHAZAD CITY is EC 369 µS/cm within the limit for drinking purpose as compared to WHO purposed standard is that EC not greater than 400 µS/cm.

Figure 4.6 Electric conductivity digital meter

4.2.3 Concentration of TDS

All the mean values of TDS in samples are presented in tables [4.1(b), 4.2(b),4.3(b),4.4(b)] and figures [4.1,4.2,4.3,4.4]. Concentration of TDS obviously diverse from place to place in the study area and the value of TDS varies from 440 mg/l to 820 mg/l. Minimum TDS Values 0.44ppt or 440 mg/l found at SHAZAD city WHO proposed standard of TDS in ground water is 1000 mg/l. The results reveal that the TDS of all four samples are within the limit as compared to WHO purposed standard.

Figure 4.7 TDS meter

4.2.4 Concentration of chlorides (Cl)

Chloride (Cl) is another element which is present in the water and high concentration of chloride has some serious effects on humans. The concentrations from 36 mg/l to 255mg/l in the study area are shown in tables [4.1(b), 4.2(b),4.3(b),4.4(b)] and figures [4.1,4.2,4.3,4.4]. The minimum value of chloride 36 mg/l at KALAT and maximum value of chloride 255 mg/l at CHAMROK. The result overall are within the limit as compared to WHO desirable standard.

4.2.5 Concentration of Sulphate (SO4)

All mean values of Sulphat (SO4) are shown in table tables [4.1(b), 4.2(b),4.3(b),4.4(b)] and figures [4.1,4.2,4.3,4.4]. The maximum concentration of Sulphat 339 mg/l found at

BAGHBANA while minimum sulphate 1.71 mg/l at KALAT. The study results show that all the sample values were in limit except BAGHBANA and CHAMROK as compared to WHO recommended values.

4.2.6 Concentration of iron (Fe) and manganese (Mn)

All mean values of iron (Fe) and manganese (Mn) are shown in tables [4.1(b), 4.2(b),4.3(b),4.4(b)] and figures [4.1,4.2,4.3,4.4] are Bellow the detection limit which do not Effect the health only effect the taste and color so the results Shows that all samples values are Bellow the WHO recommended values for iron (Fe) 0.3mg/l and for manganese (Mn) 0.5mg/l.

4.2.7 Concentration of Arsenic (As)

Arsenic (As) is element which is present in the water and high concentration of Arsenic (As) has some serious effects on Humans health. All the values of Arsenic (As) are shown in the tables [4.1(b), 4.2(b),4.3(b),4.4(b)] and figures [4.1,4.2,4.3,4.4]. The study results show that all the sample values were in bellow the detection limit except water sample of BAGHBANA have Arsenic (As) 6.38 µg/l or 0.00638 mg/l which is less than as compared to WHO recommended values 10µg/l or less than 50µg/l or 0.05mg/l.

4.2.8 Concentration of Lead (Pb)

Lead (Pb) presence in the water is basically comes from plumbing and plumbing fixtures and it is a powerful neurotoxin, which mean that it Damage the brain. It can also injure other soft tissues and organs. As in the above tables table [4.1(b), 4.2(b),4.3(b),4.4(b)] and figures [4.1,4.2,4.3,4.4] some amount of lead present in the water sample (Pb) 2.3 µg/l or 0.0023mg/l at CHAMROK, (Pb) 0.2 µg/l or 0.0002mg/l at KALAT which is less than then as compared to WHO recommended values 10 µg/l or 0.01mg/l.

4.2.9 Concentration of Cadmium (Cd)

Cadmium (Cd) is extremely toxic and accumulate in the kidneys and liver in the above table [4.1(b), 4.2(b),4.3(b),4.4(b)] and figures [4.1,4.2,4.3,4.4] some amount of cadmium (Cd) are present in the water sample such as; (Cd) 0.27 µg/l or 0.00027mg/l at CHAMROK, (Cd) 0.27µg/l at KALAT, (Cd) 0.18 µg/l or 0.00018mg/l at BAGHBANA and (Cd) 0.22 µg/l or 0.00022mg/l at SHAZAD city which less than as compared to WHO recommended values 0.003mg/l.

4.3 Water Quality Index (WQI) Method

WQI is an indicator of measuring water quality and suitability for drinking and surmises many parameters of water samples' results for understanding if the water is drinkable or not. The equation of WQI model is given:

$WQI=\sum Wi*Qi$ ------(1)

where Qi is the ith WQ parameter, Wi is the weight associated with the ith WQ parameter, and n is the total number of WQ parameters.

Table 4.5 physiochemical parameters of different sites for WQI

Parameters	Site 1	Site2	Site3	Site4
PH	6.9	7.2	7.4	7.5
TDS	820	720	806	440
EC	777	651	702	369
Chlorides	255	36	164	48
Sulphate	283	1.71	339	106
Iron	0.04	0.04	0.04	0.04
Arsenic	0.13	0.13	6.38	0.13
Manganese	0.05	0.05	0.05	0.05
Lead	2.3	0.2	0.25	0.25
cadmium	0.27	0.27	0.18	0.22

Where;

Site 1= CHAMROK District KHUZDAR

Site 2=KALT city

Site 3=BAGHBANA District KHUZDAR

Site 4=SHAZAD city District KHUZDAR

After using the water quality index WQI calculation

Table 4.6 WATER QULITY INDEX WQI RATING

S. No.	QWI value	Rating
1	0-25	Excellent
2	25-50	Good
3	50-75	Poor
4	75-100	Very poor
5	>100	Unsuitable for drinking

4.6 WQI Analysis

The groundwater quality of the study area (KALAT Region) calculated by **WQI** indicates that the water lies in Good category while only one sample (S) lies under the Unsuitable for drinking category having unsatisfactory result with WQI above 100. In this study, the computed WQI values range from 25-110. The overall view of the WQI of the study area water quality are Good.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The present study focused on the variation of ground water quality of KALAT region by using the water quality index WQI. The groundwater of the study area is physically and chemically contaminated. Both natural process and anthropogenic activities are responsible for polluting the groundwater. Most of the physiochemical parameters are within the limit as compared to WHO desirable standard.

The main physiochemical parameter deteriorating the quality of groundwater are Chloride (Cl), Sulphate (SO4), PH, Electric conductivity (EC), Total dissolved solids (TDS), Iron (Fe), Arsenic (As), Manganese (Mn), Cadmium (Cd), Lead (Pb). It is concluded that the groundwater quality of KALAT region is almost safe for drinking purpose because of its WQI range 25-110, only some location such as; the groundwater quality of CHAMROK District KHUZDAR have WQI is >100 Because having high contents Chlorides (Cl) 255mg/l and Sulphate (SO4) 283mg/l which is against of WHO guideline and standard so the groundwater of that region is unsafe for drinking purpose, but overall the water quality is Good and safe for drinking purpose.

5.2 RECOMMENDATION

The overall groundwater quality of the study area (KALAT region) are good and safe for drinking purpose only one of sample of the study area such as; CHAMROK District KHUZDAR are unsafe for drinking purpose Because having high contents of Chloride (Cl) and Sulphate (SO4).

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