Sudan University of Science and Technology

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Title:

Assessment Of quality Of Drinking groundwater in south Omdurman City , Sudan

تقييم جوده المياه الجوفية للشرب في منطقة جنوب ام درمان _ السودان

A Thesis submitted in partial fulfillment for the Requirement of the degree of master In Water Resource and Environmental Engineering.

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قال تعالى:

﴿ أَوَلَمْ يَرَ الَّذِينَ كَفَرُوا أَنَّ السَّمَاوَاتِ وَالْأَرْضَ كَانَتَا رَتْقًا فَفَتَقْنَاهُمَا وَجَعَلْنَا

مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ أَفَلَا يُؤْمِنُونَ ﴿30﴾ ﴾

صدق الله العظيم

سورة الأنبياء الآية 30

Dedication

For my family , my friends

And special thanks from myself and my colleagues in master program.

Acknowledgment

I would like to acknowledgment everyone who played a role in my academic accomplishment .first of all, my parents , who supported me and understanding . I could never reached this current level of success.

Secondly , my committee members , each of whom has provided patient advice and guidance throughout the research process. Thank you all for your unwavering support.

Abstract

This study has been carried out in south Omdurman city, Khartoum state, Sudan for six groundwater wells .

Chemical analysis was carried out for physical and chemical parameters, the results were showing the fitness of the groundwater for drinking purposes and domestic uses.

The purpose of the study was to determine The quality of the ground water in study Area.

Omdurman Islamic university ground water was Suitable for drinking water Because all parameters were within the level of standards of WHO.

Abusied 18 Abusied 62, Abusied 30 and jadeen: Turbidity water and Chemically valid for human use.

Sallha hejeleja water well : Not suitable for drinking because containing high percentages of TDS (1642 mg/l) , chloride (420 mg/l), sulfate (265 mg/l) Compared with WHO for drinking water.

The study recommends According to chemical and results there should be treatment for high turbidity in water wells Abusied 18 Abusied 62 Abusied 30 and jadeen for the drinking water to be fit for human uses and domestic Salha hejelija water well I recommend to stop using its water due to high TDS, high chloride and sulfates.

المستخلص

تم إجراء هذه الدراسة في منطقة جنوب امدرمان ولاية الخرطوم (السودان)، وكان الغرض من اجراء الدراسة معرفة مدى صلاحية المياه الجوفية فيا لمنطقة لأغراض الشرب وأغراض الاستخدام المنزلي.

لقد تم تعيين 6 (ستة) ابار المياه الجوفية لأخذ عينات المياه ومن ثم تحليلها فيزيائياً وكيميائياً ومعرفة أهم الخصائص الفيزيائية والكيميائية، ومن ضمن الابار هناك بئر جامعة امدرمان الإسلامية مياهه صالحة للشرب والاستخدام المنزلي، اما ابار أبو سعد مربع 18 وأبو سعد مربع 30 وأبو سعد مربع 62 وجادين من ناحية كيميائية صالحة للإستخدام المنزلي رغم أنها تحتوي على نسبة عالية من العكارة، أما بئر صالحة هجيليجة غير صالحة للشرب لاحتوائها على نسب عالية من الأملاح الذائبة الكلية (TDS) (1642 mg/l) والكلوريد (cl-) (420 mg/l) والكبريتات ($so, ^{-2}$.) (265 mg/l) إذاً فإننا نوصي بإيقاف ضخها.

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Chapter one

Introduction

1-1: Background:

Groundwater is water that exists underground in saturated zones beneath the land surface. The upper surface of the saturated zone is called the water table.

Contrary to popular belief, groundwater does not form underground rivers. It fills the pores and fractures in underground materials such as sand, gravel, and other rock, much the same way that water fills a sponge. If groundwater flows naturally out of rock materials or if it can be removed by pumping (in useful amounts), the rock materials are called aquifers.

Groundwater moves slowly, typically at rates of 7-60 centimeters (3-25 inches) per day in an aquifer. As a result, water could remain in an aquifer for hundreds or thousands of years. Groundwater is the source of about 40 percent of water used for public supplies and about 39 percent of water used for agriculture in the United States.

1- The Earth's water cycle begins with oceanic water, which covers about three-quarters of the Earth's surface. Due to its exposure to the sun, evaporation evaporates and the clouds build up. Under certain conditions clouds condense and fall in the form of rain, cold or snow. The various forms of falling water are known as the originals of freshwater, which are the main source of fresh water on the surface of the earth, some of which are carried out to rivers, valleys and lakes. The second section is penetrated into the surface so that most of it remains in the root area of the plants and is

again brought back to the surface by plants or wild in the poetic properties. The water reservoir enters the soil and a small percentage of penetration continues to the bottom of the root area under the influence of gravity. When connected to the groundwater, the transient water moves horizontally into the pores of the water-saturated layers and may appear again on the surface in the form of springs in some areas where the level of the Earth's surface falls below that of the water. The spring water is once again on the surface with surface water to the oceans and this water movement is known as the water cycle. [https://en.wikipedia.org/wiki/Groundwater]

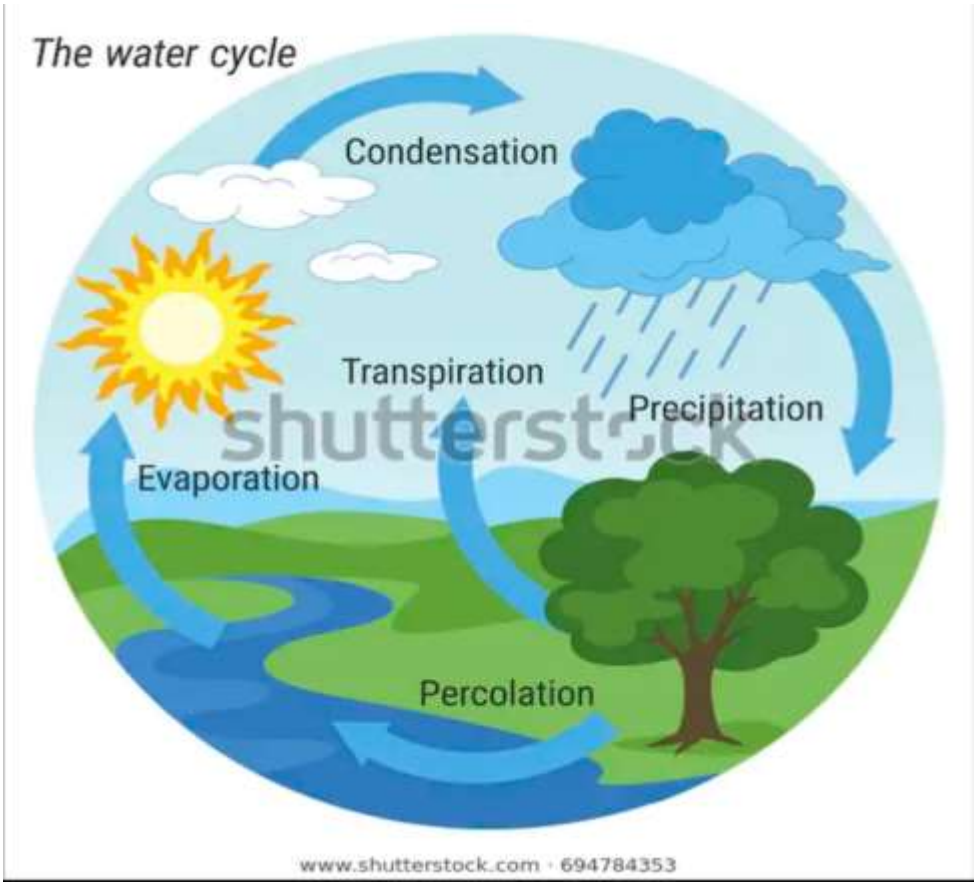

Figure (1.1): The Water Cycle.

1-2: Environmental Setting of the Study Area:

1-2-1: Location:

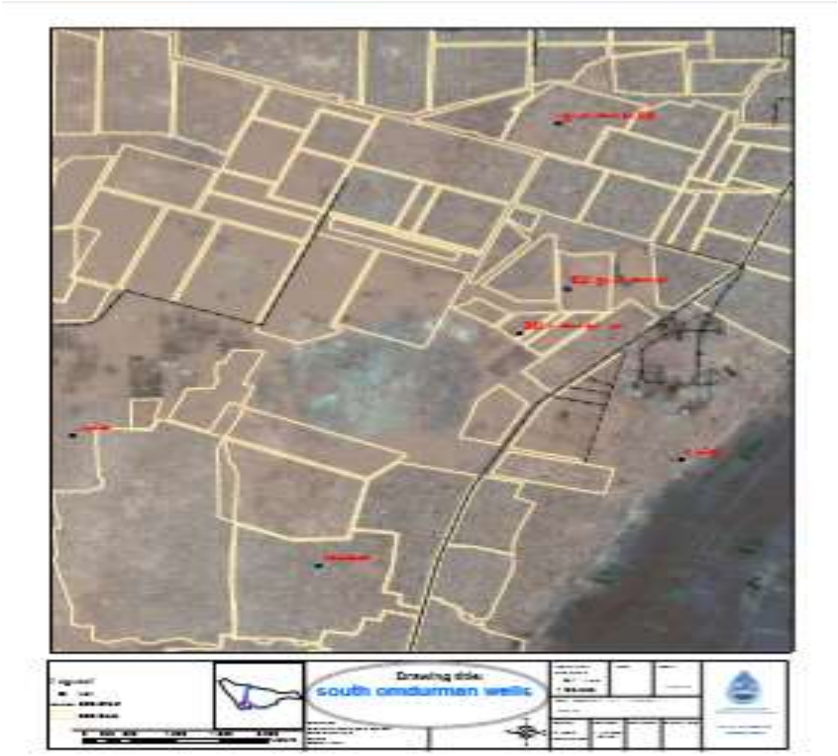

Figure (1.2): Location of the Study Area

1-2-2: Climate:

The state of Khartoum is located in the semi-desert climatic zone and its climate is hot to very hot and rainy in summer and dry to cold and dry in winter. The amount of rainfall in the north-east is between 100-200 mm and in the north-west between 200-300 mm and temperatures in the summer between 25 - 40 ° C in the months of April to June and from 20-35 ° C in the months of July to October temperatures continue to decline in the separation between 15-25 ° C in the months from November to March.

1-3: Problem Statement:

Groundwater is essential for the human life, economy, stability, and development as good quality more comfortable source of drinking water attracted the attention globally. In the past, people in the study area depend mainly for their

activities on the surface water from the Blue Nile and the River Nile, seasonal steam and few wells extracted water from the groundwater, especially in areas near the Nile, but in remote area they rely on groundwater, although some salinity hazards, biological contaminations as well as insufficient quantity were encountered. With respect to the expansion of residential area and the consequence water demand, more attention should be focused on groundwater to meet the water requirements for present and future development. Accordingly, more interest to evaluate the ground water quality in the study area is the main target.

1-4: Objectives:

-To Determine The Quality Of The Groundwater In Study Area

-To Investigate The Tap Water Quality In Study Area

-The Find Out The Physical And Chemical Parameters Of The Groundwater And Tap water

Chapter Two
Literature Review

Chapter Two

Literature Review

2-1: Water Quality:

The quality of aquatic environment shows temporal and spatial variations due to factors internal and external to the body.

2-1-1: Concept of Water Quality:

Water quality is determine the concentration of its components and additions to it, and then comparing the results of this concentration with the purpose for which it will be used.

so it is not possible to measure quality without specifying the purposes used, because water used in households for drinking and preparing food is different from that used for fish breeding, or those used to irrigate crops, while the seas and oceans are characterized by high quality for many fish species, they are not suitable for some other organisms, including humanity. (Chapman.D,1992)

2-1-2: Water Quality Measurement Standards:

- Physical of measurements water quality:
  -Temperature:

Directly affect biological processes in water, where high temperature leads to lower concentration of dissolved oxygen in the water.

- - color, taste and smell of water:
  It is known that water has no taste, no color, no odor, so the presence of any characteristic of these qualities means water contamination. (Kagely,1998)

- -Electrical Conductivity:

  The electrical conductivity reflects the amount or concentration of dissolved substances in water.

- -turbidity:

  the water turbidity is measured by using a ski plate painted with color triangles, some black and others white, which enters the water to measure the depth at which the colors disappeared, the more the colors disappear

in a less depth, the higher Turbidity ratio, the turbidity meter is expressed in NTU units.

-Chemical standards for water quality:

-pH:

The ratio of acidic or basal water, where pH is measured in the area of 0 14, and when the pH = 7 ratio is equal, if less than 7 is acidic, but more than 7 is the base.

-Salinity:

Salts are usually found in the water in a natural way, resulting from the melting of rocks or salts in the soil, or in an unnatural way by the human being through the use of chemical fertilizers or mixing potable water with sewage.

-Nitrate and phosphate:

The increase in nitrate and phosphate in water leads to the rapid reproduction of plant organisms in water, especially algae, which reduces photosynthesis of plants, concentration of oxygen and the death of most organisms living in water, and the increase of nitrate in the waters Drinking leads to their contact with hemoglobin in red blood cells, obstruction of oxygen transmission in the body and the incidence of cyanosis, especially in children.

-Sodium:

The taste threshold concentration of sodium in water depends on the associated anion and the temperature of the solution. At room temperature the average taste threshold for sodium is about 200 mg/l.

-Sulfate:

The presence of sulfate in drinking water can cause noticeable taste. It is generally considered that taste impairment is minimal at levels below 250 mg/l.

-Hydrogen Sulfide:

Hydrogen sulfide in water is estimated to be between 0.05 and 0.1 mg/l. It is particularly noticeable in some ground waters and stagnant drinking

water in distribution system as the result of oxygen depletion and the subsequent reduction of sulfide by bacterial activity, sulfur is oxidized rapidly to sulfide in well.

Total Dissolved Solids:

TDS can have an important effect in the taste of drinking water with a TDS level of less than 600 mg/l is generally considered to be good. Drinking water becomes increasingly unpalatable at TDS level greater than 1200 mg/l. Water with concentrations of TDS below 1000 mg/l is usually acceptable to consumers.

Manganese:

Concentrations of manganese less than 0.1 mg / l are usually acceptable to consumers. At a level higher than 0.1 mg / l of manganese in water supply stains, sanitary ware and washing, causes undesirable taste in drinks. May lead to accumulation of deposits in the distribution system. Even at a concentration of 0.02 mg / l, manganese often forms a layer on the tubes, which may fade at black deposits.

Nitrate and Nitrite:

Nitrate and Nitrite are naturally occurring ions that are part of nitrogen cycle. Naturally occurring levels in surface and groundwater are generally a few milligrams per liter. In many groundwater increase of nitrate level has been observed owing to the intensification of farming practice.

Fluoride:

The concentration of fluoride is critical for dental health in children. Too high concentration can result in dental fluorosis, in some children, but small amount is essential for the prevention of dental caries. The desirable concentration varies with age rage ambient temperature; it should be 0.9-1.7 mg/l at 10 C°, 0.7-1.2 mg/l at 20 C° and 0.6-0.8 at 30 C°.

Groundwater may contain about 10 mg/l in areas rich in fluoride containing minerals. The guideline value suggested 1.5 mg/l.

Chloride:

Large quantities of chlorides are usually present in surface and groundwater, pollution of water by industrials activities might be the cause for further increase in chloride in chloride concentration.

Free Ammonia:

Free ammonia represents the first product of decomposition of organic matter, thus appreciable concentration of free ammonia usually indicate "fresh pollution" of sanitary significance amount in the range of 0.2 to 2.0 mg/l is toxic many fish.

Alkalinity:

The alkalinity of water passing through iron distribution system should be in the range of 30-100 mg/l as $CaCO_3$ to present serious corrosion, up to 200mg/l is standpoint of pH, hardness, carbon dioxide and dissolved oxygen content-corrosion of iron pipe is prevented by the maintenance of calcium carbonate stability-sufficient alkalinity is needed to water react with added alum to form a flock in water coagulation. Bathing or washing in water of excessive alkalinity can change the pH of the lacrimal fluid around the eye, causing eye irritation.

Hardness:

Hardness results from the present metallic cautions of which calcium and magnesium are the most abundant in groundwater.

Water hardness:

Water hardness means the concentration of calcium and magnesium ions combined in water, the more concentrations of these ions increase the hardness of the water, thereby increasing the deposition in salts.

Heavy metals:

Minerals in water affect human health, whether natural minerals from rock melting, or industrial minerals caused by wastewater. (Kagely,1998)

2-1-3: Importance of Water:

Water is considered an economic good, therefore, each unit of it should be used efficiently, equitably and soundly. (Chapman.D.1992)

2-1-4: Water Safe and Wholesome:

Water intended for human consumption should be both safe and wholesome. This has been defined as water that is:

-Free from pathogenic agents

-Free from harmful chemical substances

-Pleasant to taste, free from odor and color

Usable for domestic purposes (Chapman.D,1992)

2-1-5: Water Requirements:

The basic physiological requirements for drinking water have been estimated at about 2 liters per head per day.

This is just for survival, but from the standpoint of public health and improvement of the quality of life, water should be provided in an adequate volume. It will help to reduce the incidence of many water related diseases among the people most at risk. The consumption of water, however, depends upon climatic conditions, standard of living and habits of the people. A daily supply of 150-200 liters per capita is considered an adequate supply to meet the needs for all domestic purposes. (Chapman.D,1992)

2-1-6: Uses of Water in a Community:

There are many uses and the requirements in quantity are varied. Conventionally, it has used convenient in quantity to serve all uses and suitable in quantity to meet drinking requirement. (Rama,**1986**) Uses of water include:

-Domestic uses: On domestic front water is required for drinking, cooking, washing and bathing, flushing of toilets gardening etc.

-Public purposes: Cleaning streets, recreational purposes like swimming pools, public parks.

-Industrial purposes: For processing and cooling.

-Agricultural purposes: Irrigation, power production from hydropower and steam power.

2-1-7: Source of Water:

The source of water commonly determines the nature of the collection purification, transmission, and distribution works.

Common sources of fresh water and their development area. (Warren,2003)

2-2: Groundwater:

Groundwater is one of the most important sources of water for human life and for flora and fauna. It is generally considered to be safer source of drinking water than surface water where can be contaminated by physical, chemical and biological pollution

Groundwater is the water present beneath Earth's surface in soil pore spaces and in the fractures of rock formations.

1- Groundwater is the water found underground in the cracks and spaces in soil, sand and rock.Underground reservoirs contain much more water than the capacity of all reservoirs and surface lakes. [https://en.wikipedia.org/wiki/Groundwater].

]

Groundwater is an underground wealth of clean, healthy water that is good for human and humanitarian use, stored in the depths of the globe, estimated at 97%, or approximately 100, 000 km², while surface water represents only 3% of the total water that forms three-fourths of the globe.

Groundwater contamination occurs when man-made products such as gasoline, oil, road salts and chemicals get into the groundwater and cause it to become unsafe and unfit for human use. Materials from the land's surface can move through the soil and end up in the groundwater.

Groundwater pollution is almost always the result of human activity. At highly populated areas and groundwater are particularly vulnerable. Any activity that may release chemicals or waste into the environment, either intentionally or accidentally able to pollute groundwater.

1- Contaminated groundwater is less clear and more difficult to clean up than pollution in rivers and lakes. Groundwater pollution often results from

improper disposal of waste on the ground. [https://en.wikipedia.org/wiki/Groundwater]
]

2-2-1: Groundwater Resources:

Groundwater is the portion of the Earth's water cycle that flows underground. Groundwater originates from precipitation that percolates into the ground. Percolation is the flow of water through soil and porous rock.

The main source of groundwater is the rain from the sky, whether cold, snow or normal, and the melting of icebergs due to the warming of the Earth over the years and the seasonal and permanent rivers as well, as these sources leak into the earth depending on the type of soil in contact with them. and rocks, the more porous and disjointed the soil or rocks, the more water it leaks from the soil or the porous rigid rock, the rain water, the rivers and the ice; there are other sources of groundwater, as follows:

-Fossil water:

-Al-Smelter Water:

-Salt water:

2-2-2: Groundwater Location:

Groundwater is all water beneath the surface of the Earth, which is the equivalent of water on the surface of the earth and is called surface water, and groundwater is located in two different regions, namely the saturated water area and the unsaturated zone.

-The unsaturated zone is located directly beneath the surface of the Earth in most areas and contains water and air and has less pressure than atmospheric pressure, which prevents the water in that area from exiting to any well dug, a layer of fish and directly beneath the saturated zone.

1- -The saturated zone is a layer containing water-bearing materials and all the voids connected to each other are filled with water and the pressure is greater than atmospheric pressure, which allows the water to go out to the well, feeding the saturated area through the infiltration of water from the surface of the earth to this layer through the passage of an unsaturated. [https://en.wikipedia.org/wiki/Groundwater]

2-2-3: Utilizations of Groundwater:

Groundwater is an important source of water supply throughout the world. It is used in irrigation, industries, municipalities and rural homes continue to increase.

Seismic surveys are conducted by firing a charge of explosive near the ground surface and timing the travel of resulting shock, waves to a series of geophones remote from the shot point. The velocity of the shock wave depends on type formation and the presence of water.

From the differences in indicted velocity's to the several geophones it may be possible to estimate the depth to the water table or the interface between formations. Resistively surveys make use of the fact that the depth of penetration of current between two electrodes in the soil surface increases as the electrodes spacing increases.

It is possible to estimate the relative resistivity of formation at different depth by measuring the current glow with various electrode spacing. Since the water increase the conductivity of soil or rock, the presence of groundwater may be indicated by a decrease in resistivity. Both seismic and resistivity surveys should be made and interpreted by persons trained in the work neither method specifically locates groundwater but merely indicates discontinuities which may bound and aquifer. With a few test holes as control point, large areas may be surveyed rapid by seismic or resistivity methods.

One of the main objectives behind the hydro chemical studies of ground water is to determine its suitability for the different uses. (Mark.G.Hammer,2003)

2-2-4: Quality of Groundwater:

Generally, it is recognized that the quality of groundwater is just as important as quantity. All groundwater contain salts in solution that are derived from location and past movement of the water. The quality of groundwater supply depends on its purpose. (SSMO, 2002)

Thus, need for drinking water, industrial and irrigation water vary widely. To establish quality criteria, measures of chemical, physical, biological and radiological constituents must be specified, as well as standard method for reporting and comparing results of water analysis. Dissolved gases in groundwater can pose hazards if their presence record under unrecognized. (Jerry,2003)

2-2-5: Groundwater Contamination:

Groundwater in the subsoil is inherently clean and uncontaminated, but it may be exposed to harmful contamination and bacteria as a result of external factors:

-**Agricultural activities:**

Agricultural activities represent the addition of pesticides, fertilizers, soil washing and evaporation processes, as these activities lead to the emergence of many pollutants such as pesticides and dissolved salts.

-**Human activities**:

Human activities sometimes lead to contamination of groundwater, as a result of leakage of organic waste from sewage systems or ground assembly reservoirs and absorbency pits that are abundant in villages distant from the means of services and sewage systems, where organic wastes contain in varying proportions on nitrogen compounds (ammonia or organic nitrogen).

-Industrial activities:

Industrial activities are the most dangerous source of groundwater pollution, and their impact depends on the type of industry and the way in which it is disposed of. Of course, most factories do not dispose of their waste and residues directly into the ground, but they may dispose of them in river or sea water, resulting in contamination, and leakage of heavy elements such as lead, zinc, and chromium into the aquifer, thus causing contamination of groundwater.

-**Wrongful withdrawal of groundwater**:

1- The unjust withdrawal of groundwater leads to contamination of the groundwater reservoir. [https://en.wikipedia.org/wiki/Bacteriological_water_analysis]

2-2-6: Reduction of Groundwater Pollution:

The risk of groundwater contamination can be minimized and reduced by the following methods:

1. Establishment of agricultural drainage systems with good infrastructure.

2. Reduce the use of harmful pesticides that pollute the environment and groundwater, and use non-polluting and environmentally friendly species.

3. Reduction of methods for the unfair withdrawal of groundwater by the development of drought-resistant plant varieties using traditional breeding methods or genetic engineering, in the event of extraction of groundwater for cultivation.

4. Protection of groundwater from a high salinity due to an unjust and irregular withdrawal, as a result of the presence of groundwater over high salinity, or as a result of the interference and mixing of seawater with groundwater.

5. Digging wells in safe depths with the need to regulate the withdrawal rates from those wells.

6. Reduce the presence of ground assembly tanks and drilling rigs by extending sewage systems to remote areas and villages lacking this service.

7. Supplying the wells with clean water until the contamination is moved in an area far from the well sites.

2- 8. Reduce the use of fertilizers, and use less water to irrigate crops.[https://en.wikipedia.org/wiki/Bacteriological_water_analysis]

2-2-7: Groundwater in Sudan:

Groundwater is potentially available in large areas away from Nile.

Major water aquifers cover about 50% of the surface of the country and occur either in shallow aquifer along the major seasonal steams or in deep aquifer of Nubian sand stone formation.

-The main aquifers exist under three categories:

-The Nubian sand stone aquifers.

-The detrital quaternary, tertiary. Aquifers.

-The recent alluvial wade-fill aquifers. (SSMO, 2002)

2-3: Wells:

Wells are dug or driven holes to reach the groundwater.

-Types of Wells:

-Shallow Well:

This is a dug well up to groundwater lying between surface and first impermeable layer. It is an unsafe source of water as it gets easily polluted from surface with sewage, and other impurities from surrounding seasonal ponds and plant leaves.

-**Deep Well**:

This is a dug well, which goes beyond the first impervious layer to reach the water strata below. This water is free from surface contamination, though it may be hard due to nitrites and nitrates.

-**Artesian Well**:

This is a variety of deep wells. In this, water strata lies between to impermeable layers. The strata are cup-shaped and surface of well is much lower than the upper level of water stratum tapped.

-Tube-Well:

It consists of iron-tubing (8-15 cm) driven into ground up to required depth. These are more sanitary than dug wells. Deep tube wells can serve as one of the ideal source of water supply.

-**Ideal Well**:

An ideal well is deep well with the following characteristics:

-Soil should be good and well away (60 meters) from sources of pollution.

-Site should be at a higher level to prevent draining of surface water into well.

-Site should have water roof wall from within outside consisting of clay, bricks and cement respectively.

-A parapet about ¾ meters high should be here with top sloping outwards.

-The mouth of the well should be covered to prevent leaves and other droppings from falling into the well.

-Water should be drawn by a hand pump or by a single bucket and rope only.

-Washing clothes, cleaning utensils and bathing should be prohibited near the well. Such a provision may however, be made through a short distance away from the well.

-Proper drainage of water to a safe distance should be provided. (Rama,1986)

-**Well Cleaning:**

This is usually carried out at the end of summer, when water in the well is at its lowest deep. All water, mud, stones etc are removed from the bottom, and the well is disinfected with slaked time (part to 4 parts water) or pot. Permanganate (just enough to make water pinkish). Periodic disinfection of well is carried out at night with 102 mg bleaching power per 1000 gallons of water. This ensures at least 6 hours contact needed for proper disinfection.

-**Well Inspection**:

-Depth of well and depth of water level.

-Nature of soil condition wall of the well and whether mouth is covered or open.

-Parapet its construction, height and slopes

-Any location of seasonal pools and privies, area of cone of filtration.

-Depression of water by pumping and time taken for its restoration.

-Water sample testing, water sample is collected from surface and bottom preferably at days end. (Rama,1986)

2-4: Water Pollution:

Water pollution is a growing hazard in many developing countries owing to human activity without ample and safe drinking water to provide health care to the community. (Chapman.D,1992)

Is to expose the quality of water to changes, whether physical or chemical; This change has a negative effect on organisms; it makes water unfit for the consumption of organisms, they are a major cause of life. Water pollution can be defined as damage, damage or corruption of water quality; Thus, the environmental system is generally disrupted ,and the concept of water pollution includes contamination of all streams of rivers, oceans, lakes, dams and rainwater, Groundwater and Wells. (Warren,2003)

2-4-1: Types of Water Contamination:

The types of water contamination are divided into two main categories:

-Natural contamination:

> This is the pollution that occurs in the natural characteristics of water to make it unacceptable or suitable for human use; This occurs under the influence of temperatures or salinity or the increase in the number of suspended substances; It is indicated that high salinity rates are often due to higher evaporation in water Lakes or rivers, it leaves a foul odor in the water and changes its color and taste.

-Chemical contamination:

> water is contaminated as a result of human intervention by dumping hazardous chemicals into water, such as lead compounds, mercury and insecticides; this contamination is a direct threat to all fish and marine organisms. (Warren,2003)

2-5: Drinking Water Standards:

The purity of water has several criteria including the following:

-Be pure tasteless, no color, no odor.

-Do not carry any bad effects to health

-be neutral and non-acidic.

-free of heavy metals such as lead, mercury, arsenic, nitrates and iron, the lead ratio may not exceed 10 mg/L.

-free of any biological contaminants such as germs, microbes and vectors

-free of any impurities, natural or biological plankton, and the presence of any inorganic or organic compounds.

-the degree of electrical conductivity at 28 º C is equal to 0.0004 Micro banana/cm², and the degree of thermal conductivity at 40.8 º C is equal to 1.555 watts per meter, and the degree of refractive index at 20°c is equal to 1.33 units, and its vapor pressure at 20 hundred degrees is equal to 17.62 mm Hg, and its quality temperature at 1 °c is equal to 1.00 kJ/kg degree. (WHO,2006)

Chapter Three

Materials and Methodology

Chapter Three

Materials and Methodology

3-1: Data Collection:

Collection of water samples:

The groundwater wells data has been collected from khartoum water corporation as secondary data .

3-2: Sampling Methods for Physical and Chemical Analysis:

All precautions were considered to collect samples which are representative as far as possible of the water to be examined in accordance with methods of laboratory test of water.

The water samples collected for chemical and physical analysis were used to determine pH, color, temperature, turbidity (NTU), odor, total hardness (TH), total alkalinity (T ALKA), chlorides (CL), nitrates (NO_3), ammonia (NH_3), sulfate (SO_4) and fluoride (F) .

3-3: Methods of Analysis:

- pH was measured by pH meter.

- Electrical Conductivity (EC) was measured at temperature 25C° by conductivity meter.

- Turbidity is measured in NTU: Nephelometric Turbidity Units. The instrument used for measuring it is called nephelometer or turbid meter, which measures the intensity of light scattered at 90 degrees as a beam of light passes through a water sample.

- Sodium (Na) was obtained by 543 nm flame photometer.

- Calcium (ca) and Magnesium (mg) were determined by titration with EDTA – disodium salt solution (0.01 M).

- Fluoride (F^-) was determined by Alizarin visual method (reaction between fluoride and zirconium Dye Lake). Fluoride reacts with dye lake, dissociating apportion of it into colorless complex anion (ZrF_6). As the amount of fluoride increases, the color produced becomes progressively lighter or of different hue.

- Chloride (CL^-) was determined by filtration using standard nitrate solution (0.014) and potassium chromate (5%) solution as an indicator.

- Sulfate (SO_4^{-2}) was determined gravimetrically by ignition. Sulfate is precipitated in HCL solution as barium sulfate, thus by addition of Barium Chloride, the precipitation was carried out near boiling temperature. Then after digestion the precipitate was filtered. Washed with water be free of CL^-, ignited and weighed as $BaSO_4$.

- Total hardness (TH) was obtained by calculation from and determined concentrations.

- Nitrate (NO_3^-) was determined by Cadmium reduction method. NO_3^- is reduced almost quantitatively to nitrite (NO_2^-) in the presence of Cadmium. The NO_2^- produced thus determined calorimetrically.

A correction may be made for any NO_2^- present in each sample by analyzing excluding the reduction step. Total alkalinity was obtained by EDTA titration method.

- Total dissolved solids (TDS) were determined by multiplying the electrical conductivity (EC) value obtained by 640.

Chapter Four
Result and Discussion

Chapter Four

Result and Discussion

4-1ResultS :

The groundwater wells data has been collected from khartoum water corporation as secondary data and the results were as follows .

4-1-1: The Results of Physical Analysis:

Table (4.1) Physical parameter of water wells in study area:

No.	Locality	Longitude	Latitude	Odor	pH	Turbidity	EC	Temperature
1	Omdurman Islamic university	15.56676	32.449632	-	7.4	5.5	1346	31.4
2	abusied 18	32.26170	15.36318	-	7.4	10.7	732	30.9
3	Abuseid 62	1723071	0439910	-	6.9	11.7	6397.	28.6
4	Abuseid 30	3226049	1534408	-	7.6	55.2	1646	29.7
5	Sahha hejeleja	32.405844	15.556362	-	7.2	3.8	2985	24.7
6	Jadeen	172093	172093	-	7.1	10.7	598	28.0

4-1-2: The Results of Chemical Analysis:

Table (4.2) Chemical parameter of water wells in the Study Area:

No.	Locality	Longitude	Latitude	TDS	TSS	T-Alkalinity	T-Hardness	Iron	CL^-
1	Omdurman Islamic university	15.56676	32.449632	740	-	220	310	0.02	156
2	abusied 18	32.26170	15.36318	439	-	246	176	0.04	38
3	Abuseid 62	1723071	0439910	352	-	174	240	0.05	52
4	Abuseid 30	3226049	1534408	805.17	-	248	340*	0.04	196
5	SaLha hejeleja	32.405844	15.556362	1642	-	240	65*	o.o4	420
6	Jadeen	172093	172093	391	-	200	116	3.0	28

No.	Locality	SO_4^{-2}	Ca^{-2}	Mg^{-2}	Na	F^-	No_3^-	No_2^-	NH_4
1	Omdurman Islamic university	86	67.2	34.08	104.4	0.43	2.8	0.055	0.75
2	abusied 18	28	35.2	21.12	64.8	0.15	1.7	0.041	0.25
3	abusied 62	49	40	33.6	23.6	0.51	2.0	0.032	0.61
4	abusied 30	116	57.6	47.04	149.12	0.62	3	0.239	0.63
5	Sallha hejeleja	265	124.8	81.6	217.5*	0.62	5.6	0.039	0.82
6	Jadeen	13	24	13.44	60	1.2	2.4	0.023	0.5

4-2 Discussion

- Omdurman Islamic university: All parameter above within the permissible level of drinking water standard.

-Abusied 18: The amount of turbidity exceed the permissible level of drinking water .

- Abusied 62: Amount of manganese and turbidity exceed the permissible level of drinking water other within limits.

-Abusied 30: Very hard water * , Amount of turbidity exceed the permissible level of drinking water.

- Sallha hejeleja : un fit for drinking.

- Jadeen: positive color , Amount of turbidity and iron exceed the permissible level of drinking water standard.

Chapter Five

Conclusions and Recommendations

Chapter Five

Conclusions and Recommendations

5-1: Conclusions:

Omdurman Islamic university: Suitable for drinking water Because all parameters within level permissible of drinking water standards.

Abusied 18 ,Abusied 62 ,Abusied 30 and Jadeen : Turbidity water and Chemically valid for human use.

Sallha hejeleja: Not suitable for drinking , contain a high percentage of TDS (1642) , chloride (420) , sulfate (265) Compared with WHO for drinking water.

5-2: Recommendation:

- According to chemical and results there should be treatment for high turbidity in water wells Abusied 18 ,Abusied 62 ,Abusied 30 and jadeen for the drinking water to be fit for human uses.
- Salha hejelija I recommended to stop using its water due to high TDS , high chloride and sulfat.
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Appendixes

Appendixes 1:

WHO Standards

WHO Drinking Water Specification Table:

Characteristic/Ingredient	Global Standard in mg/L
Color (TCU)	15
TDS	1000
Suspended Solids	0
Turbidity (NTU)	5
PH	6.5-8.5
Dissolved Oxygen	0
Water Hardness	500
Nitrogen ammonia	0
Ammonium	0
Nitrate Nitrogen	10
Nitrate	0
Nitrite	0
Phosphorus	0
BOD limits	0
BOD Sodium	200
Chloride	250
Sulfate	400
Sulfide	0
Fluoride	1.5
Boron	0
Cyanide	0.1
Aluminum	0.2
Arsenk	0.05
Barium	0
Cadmium	0.005
Chromium	0.05
Cobalt	0
Copper	1
Iron	0.3
Lead	0.05

Manganese	0.1
Hg	0.001
Nickel	0
Selenium	0.01
Zinc	5
Petroleum	0
Total Pesticides	0
Individual Pesticides	0
Aldrin and Dieldrin (Insecticides)	0.03
Dichlorobiphenyl trichloroethane	1
Lindane (gamma - HCH)	3
Methoxy Chlorine	30
Gasoline	10
Hexachlorobenzene	0.01
Pentachlorophenol	10
Phenols	0
Cleaners	0