

1. Introduction :

1.1 Importance of Water:

Water is vitally important for life maintenance. Over years, water quantity and quality has been regarded as limiting factor in controlling the size and shape of human settlement . Water is an excellent stable solvent needed for dehydration synthesis and hydrolysis.

On the other hand there is a surprising connection between quality of drinking water and health . As a waste carrier it can be responsible from many water-borne diseases such as cholera and typhoid fever^[2].

1.2 Water Resources:

Water resources are useful to human, animals, and plants. Many uses of water including agricultural, industrial, household recreational and environmental activities virtually require fresh water.

Only 3% of water on the earth is fresh water and over two thirds of this is frozen in glaciers and polar ice caps ^[4].

Water demand already exceeds supply in many parts of the world and many more areas are expected to experience this imbalance in the near future. The framework for allocating water resources to water users is known as water rights ^[4] .

1.2.1 Fresh Water Sources :

1.2.1.1 Surface Water :

Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation and sub-surface seepage.

Although the only natural input to any surface water system is precipitation within its watershed, the total quantity of water in the system any given time is also depending on many other factors, these factors include storage capacity in lakes, wetlands and artificial reservoirs the permeability of the soil beneath these storage bodies, the runoff characteristics of the land in the watershed, the timing of the precipitation and local evaporation rates. All of

these factors also affect the proportion of water lost through discharge to the oceans, seas , and sub-surface seepage.

The total quantity of water available at any time is an important consideration ^[7].

1.2.1.2 Ground water:

Ground water is water located in the pore space of soil and rocks. It is also water that is following with in aquifer below the water table. Sometimes it is useful to distinct between Sub-surface water that is closely associated with surface water and deep Sub-surface water in aquifer (some time called (fossil water)).

Sub-surface (ground water) can be thought of in the same terms as sub-surface water in puts, out puts and storage.

The critical difference is that sub-surface water storage is generally much larger compared to inputs than it is for surface water. This difference makes it easy for human to use sub-surface water unsustainably for a long time without severe consequences. Nevertheless, over the long time the average rate of seepage above a subsurface water source is the upper bound for average consumption of water from that source.

The natural input to sub-surface water is seepage.

If the surface water source is also subject to substantial evaporation a sub-surface water source may become saline.

Water in the underground are in sections called aquifers. Rain rolls down and come into these. Normally an aquifer normally depends on the grain size^[7].

1.3 Water uses:

Uses of fresh water can be categorized as consumptive if that water is not immediately available for another use.

Losses to sub-surface seepage and evaporation are considered consumptive.

Water that can be treated and returned as surface water, such as generally considered non-consumptive ^[9].

1.3.1 Drinking water:

Drinking water or potable water is water pure enough to be consumed or used with low risk of immediate or long term harm. The most developed countries the water supplied to households commerce and industry is all of drinking water standard^[2].

1.3.2 Agricultural:

It is estimated that 70% of world-wide water use is for irrigation. In some areas of the world irrigation is necessary to grow any crop at all, in other areas it permits more profitable crops to be grown or enhances crop yield. Various irrigation methods involve different trade-offs between crop yield water consumption and capital cost of equipment and structure. Irrigation such as most furrow and over head sprinkler irrigation are usually less expensive, but also less efficient because much of the water evaporates or runs off more efficient irrigation methods include drip to trickle irrigation, surge irrigation and some types of sprinkler system where the sprinklers are operated but near ground level.

These types of systems are more expensive, can minimize runoff and evaporation. Any system that is improperly managed can be wasteful.

Another trade off that is often in sufficiently considered is Salinization of sub-surface water.

Aquaculture is a small but growing agriculture use of water. Fresh water commercial fisheries may also be considered as agriculture uses of water but have generally been assigned a lower priority than irrigation^[7].

1.3.3 Industrial:

About 15% of world-wide water use it is estimated as industrial. Major industrial users include power plants, which use water for cooling or as a power source ore and oil refineries, which use water in chemical processes and manufacturing plants, which use water as a solvent medium, etc ...^[7].

1.3.4 Recreation:

Recreation of water use is a very small but growing percentage of total water uses. Recreational use is mostly tied to reservoirs. If a reservoir is kept fuller than it needed then the water from a few reservoirs is also timed to enhance white water boating which also could be categorized as a recreation use. Other examples are anglers, water skiers and swimmers.

1.3.5. World water, supply and Distribution in future:

Food and water are two basic human needs. The future studies supply indicated that in 2025, water shortages will be more prevalent among poorer countries where resources are limited and population growth is rapid such water and adequate sanitation. This suggests growing conflicts with agricultural water users, who currently consume the majority of water used by human.

1.4 Water chemistry:

1.4.1 Chemical structure of water :

Each water molecule is composed of two hydrogen atoms and one oxygen atom. The nature of the bond that holds these atoms together is important, and even more important is the bond that formed between molecules of water, for this bond determines water's special properties.

Each hydrogen atom contains one proton and one electron in 1S orbital. The atom of oxygen contains eight protons and eight electrons in 1S, 2S, and 2P orbitals. When two hydrogen atoms and an oxygen atom react, united by sharing a pair of electrons (this called a covalent bond). The valence shells are thus joined by a covalent bond.

In the resulting water molecule, however, the electrons are not shared equally the oxygen nucleus, with its eight protons is more attractive to the negatively charged electrons than the hydrogen nucleus with its single proton. A negative charge accumulates around the oxygen atom in the molecule and a positive charge accumulates near each of the hydrogen atoms as shown in fig (1-1).

The positive charged regions (the hydrogen) of the water molecule are attracted to the negative-charged regions (the oxygen atom) of another water molecule and strong bond called a hydrogen bond develops between the water molecules Hydrogen bonds are significant both in their strength and their dimension which result in water molecules being joined together in a three-dimensional structure fig (1-1)

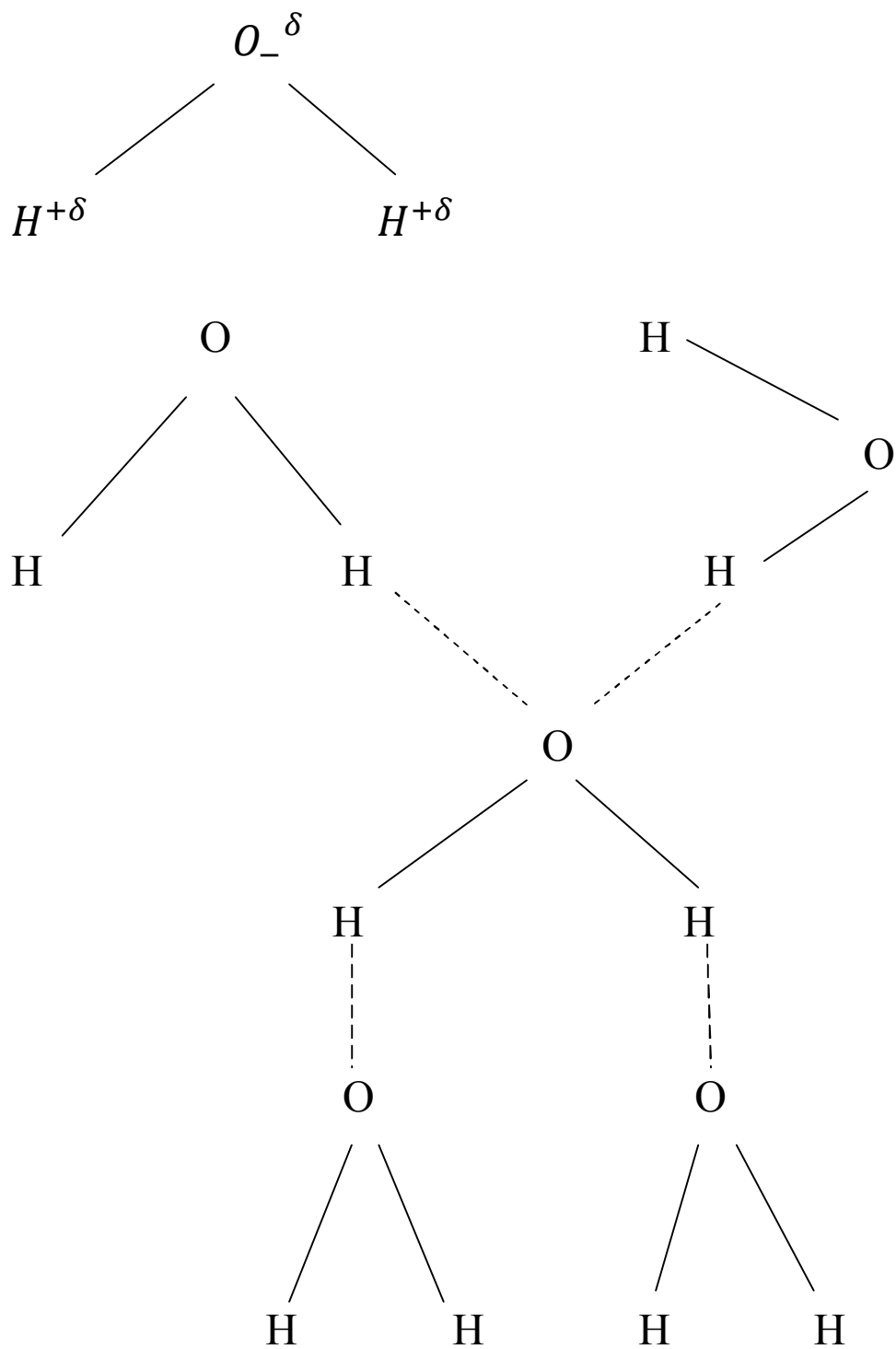


Fig.1.1:Structure of water molecules

1.4.2 Physical Characteristics:

Physical properties of water can be summarized as follows.

1.4.2.1 States:

Water is unique in found in all three states Liquid, solid, and gas. At the temperature normally found on earth ^[7].

1.4.2.2 Temperature:

Water freezes at 32 fahrenheit (F) and boils at 212 F (at sea level). In fact, those are the base line with which temperature is measured 0 on the Celsius scale is water's freezing point and 100 is water's boiling point ^[7].

1.4.2.3 Thermal properties:

Water has a high specific heat index. this means water can absorb a lot of heat before it is being hot ^[7].

1.4.2.4 Surface tension:

Water has a very high surface tension. In other words, water is sticky and elastic, and tends to clump together in drops rather than spread out in a thin film. Surface tension is responsible for capillary action which allows water (and dissolved substances) to move through the roots of plants and through the tiny blood vessels in our bodies. The highest surface tension 73 dyne/cm is at 20°C and 1 atm ^[6].

1.4.2.5 Colour :

Even pure water is not colourless; it has a pale brown, due to suspended matter ^[6].

1.4.2.6 Taste and odor:

The familiar water is tasteless, odorless test and odor are a subjective test relies upon description rather than quantitative results. Tests tend to be closely related to odors although there are non-volatile substances, such as sodium chloride which give rise to test without causing odors ^[9].

1.4.2.7 Turbidity :

Turbidity is an indication of the clarity of water and is defined as optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through a sample of water (the turbidity is caused by material in suspension). Turbidity is an important parameter characteristic in water quality knowledge of turbidity estimation of concentration of substances^[9].

1.4.2.8 Solid Materials:

Solid materials may be present in suspension or in solution and they may be divided into organic matter and inorganic matter. Total dissolved solids (TDS) are due to soluble materials, range (< 500) ppm, whereas total suspended solids (TSS) are discrete particles which can be measured also as settleable solids range (30-70)mg/l ^{[9] [13] [15]}.

1.4.2.9 Electrical conductivity (EC):

Conductivity is the measurement of ability of solution to carry electric current. This ability is dependent upon the presence of ions in solution. The conductivity measurement is an excellent indicator of total dissolved solids in water, range (300-500) ppm ^{[9] [11]}.

1.4.2.10 Radioactivity:

Water may contain trace amounts of radioactivity caused by naturally occurring radioactive isotopes such as potassium (k^{40})^[9].

1.4.2.11 Viscosity :

It is constant limit for power friction and inclination vertical speed on the lager from the solution water has low viscosity.

1.4.3:Chemical characteristics:

Chemical characteristic to be more specific in nature than some physical parameter and are thus more immediately useful in assessing the properties of a sample.

1.4.3.1:pH value:

PH or hydrogen ion concentration is a measurement of the acidity or alkalinity, it is one of the most important determinative properties in chemistry and drinking water specially.

Water is a solvent for ionic compound .it serves as an indicator of the most water soluble ion. pure water is slightly ionized to positive hydrogen ions(H) and negative hydrogen ions (OH).

In general term a solution is said to be neutral when the number of hydrogen ions and hydroxyl ions are equal. the corresponding approximate mole/l.

This neutral point is temperature dependant and occurs pH 7.0 at 25 C.

Acidic water characteristic obtained when the concentration of hydrogen ions exceed that of hydroxyl ions $pH < 7$. The basic or alkaline water is of high hydroxyl ions concentration than hydrogen ions $pH > 7$ [11]

1.4.3.1.1::Acidity:

Most natural water and domestic sewage are buffered by CO_2, HCO_3 system.

Carbonic acid is not fully neutralized until pH 8.2 and will not depress the PH below 4.5 .thus CO_2 acidity is in pH range 8.2 to 4.5 mineral acidity.

usually due to industrial wastes occurs below pH 4.5 acidity is expressed in terms of $CaCO_3$ ^[9].

1.4.3.1.2:Alkalinity:

Alkalinity is almost entirely due to bicarbonate , carbonate or hydroxyl ions in natural water ,usually in association with calcium ,magnesium, sodium, and potassium. Most the natural alkalinity in water is due to (HCO_3^-) produced by the action on limestone or chalk .

Alkalinity is useful in water and waste as it provides buffering resist changes in pH. it is normally divided in to caustic alkalinity above PH 8.2, there fore

alkalinity can exist down to this pH because of the fact that HCO_3^- is not completely neutralized until this pH is reached .

From above there is a relationship between alkalinity, carbon dioxide and pH value, in simplest form of the relationship bicarbonate alkalinity is in equilibrium with carbon dioxide in the water between pH 4.5 and 8.2 ,when above 8.2 free carbon dioxide gas to exist and combines to give both carbonate and bi carbonate .

Alkalinity range between pH 9.4 and 10 all the alkalinity is due to caustic hydroxyl alkalinity.

1.4.3.2: Hardness:

This property of water prevents lather formation with soap and produces scale in hot water system. it is mainly due to the metallic ions Ca, Mg, although Fe, Sr, Mn are also responsible, the metal are usually associated with HCO_3^- , SO_4^{2-} , Cl^- , SO_3^{2-} , NO_3^- .

There is no hazard on hardness, the value of total hardness must be less than 100 mg/l^[12].

Hardness is expressed in terms of $CaCO_3$ and is divided in to two forms:

1: carbonate hardness metals associate with HCO_3^- .

2: Non –carbonate hardness-metals associate with Cl^- , SO_4^{2-}

Total hardness – alkalinity = Non-carbonate hardness.

If high concentration of K^+ and Na^+ salts are present the non –carbonate hardness may be negative since salts could form alkalinity without producing hardness.

1.4.3.5: Cationic and Anionic constituents

1.4.3.5.1: Sodium:

In addition to being very abundant, sodium compounds are very soluble so that the element is present in most natural waters. The taste for sodium

drinking water, depends upon several factors such as the predominate anions present and the temperature, the threshold taste concentration for sodium chloride is around 350 mg/l whereas threshold taste concentration for sodium sulphate can be as high as 1000 mg/l the use of base exchange or lime-soda processes to soften hard water can lead to a significant increase in the sodium concentration.[7]

1.4.3.5.2: Potassium:

Also potassium is an abundant natural element, however in freshwater, potassium levels are normally low. the concentration rarely exceeds 20 mg/l .higher levels can be observed in brackish water.[7]

1.4.3.5.3: Calcium:

Calcium is found in most natural waters ,the level depending upon the type of rock through which the waters has passed it is usually present as the carbonate or bicarbonate and sulphate, although in water of high salinity ,calcium chloride and nitrate can also be found, calcium contributed ,to the hardness of water with bicarbonate forming temporary, or carbonate, hardness and the sulphate, chloride and nitrate forming permanent, or non carbonate hardness, calcium is an essential part of the human diet. However, the nutritional value form water is likely to be minimal compared to that from other food sources.

There is no health objection to high calcium content in water, main limitations being made on the grounds of excessive scale formation, the WHO recommends a maximum level of 200 mg / l as Ca, 500 mg / l expressed as calcium carbonate, above which deposition in water systems can cause major problems.[5]

1.4.3.5.4: Iron:

in many natural and treated water, trace amount can usually be found in distribution system where the water has been in contact with iron pipes .iron can be present in water in numerous forms in true solution , as a colloid ,on suspension or as a complex with other minerals or organic substances . the element is not harmful but undesirable on aesthetic ground .it can impart a

bitter taste when present in a large amounts . Water contains a lot of iron ,takes up oxygen on it is exposure to air , and the iron is likely to be precipitated causing brown stains on laundry and plumbing fixtures .

Every small amounts of iron can lead to accumulation of large deposits in adistribution system as well as being unacceptable to consumer ,such deposits can give rise to iron bacteria which in turn causes further deterioration of the quality of the water by producing slimes or objectionable orders the international standers WHO 1971 recommend 0.1mg/l Fe as ahighest desirable level for total iron , with 1.0 mg/l as the maximum permissible level .the EC directive is more stringent with aguide level of 0.05 mg/l and maximum concentration of 0.2 mg/l .it should be noted however that of that of the EC directive granted taking the nature of the ground form which supply emanates, the good quality ground water accepted by WHO 1983 stander recommend 0.2 mg/l of iron as a maximum limit [1]

1.4.3.5.5: Chloride:

Chlorides ions represent compound of chlorine with other elements or radicals. They are present in nearly all natural water. The concentration range of chlorides are very wide, sodium chloride forms a common salt and calcium, magnesium chloride to lesser extent. They are one of the most stable components in water , with concentration being unaffected by most natural physiochemical or biological processes . Chlorides are derived form natural mineral deposits, form sea water either by intrusion or by airborne spray, from agricultural or irrigation discharges, or from sewage and industrial effluents. Most rivers and lakes have chloride concentration of less than 50 mg/l chloride any marked increase in the concentration of water body is indicative of possible pollution.

The main problems caused by excessive chloride in water concentration the acceptability of supply not determinate to health. The common salt sodium chloride intake for people suffering from heart or kidney disease has to be restricted.

Although the salt intake from drinking water is compared to that foodstuffs. it is still desirable to limit the chloride concentration in water. the WHO 1971 international standard set admissible level of EC 200 mg/l of chloride with a maximum permissible level of 600 mg/l the EC directive and WHO 1983 guideline recommend a much lower guide level of 25 mg/l with the comment that undesirable effects might occur above 200 mg/l were set in relation to taste and corrosion in hot water system. In this respect they are still relevant. the sensitive palate can detect chloride as low at level of 150 mg/l, whereas a concentration above 250 mg/l impairs distinctly salty taste to water. However, waters containing more than 600 mg/l are drunk in some arid or semi-arid places due to lack of alternative supply ^[11][5].

1.4.3.5.6: Sulphates:

The sulphates occur naturally in many types of waters. They are introduced in to treated water by the use of chemical sources such as aluminium sulphate .

Sulphate comes from several sources such as the dissolution of gypsum and other mineral deposits containing sulphate from sea water intrusions, oxidation of sulphide and thiosulphate in well aerated surface waters and from industrial effluents where sulphates or sulphuric acid have been used in processes such as tanning pulp paper manufacturing sulphurous flue gases discharged to atmosphere in industrial areas often result in rain waters containing appreciable levels of sulphates ^[10].

Sulphates in domestic water contribute the major part of the non-carbonate or permanent, hardness, high levels of sulphates will give rise to a taste in water and laxative effect is obtained when combined with magnesium or sodium .

Naturally occurring sodium sulphate and magnesium sulphate are both well known laxatives, consumer can become acclimatized to high sulphate of water, on the other hand some part of world water with a very high content have to be used because of no alternative supply. bacterial reduction of sulphates under anaerobic conditions will produce hydrogen sulphide .

Which is an objectionable of gas smelling of bad eggs odor . this occurs in deep well water and the odor rapidly disappears with efficient aeration .[5]

1.4.3.5.7:Nitrogen:

Nitrogen is an important element in biological systems, nitrogen exists in four main forms :

1-organic nitrogen: is the nitrogen in the form of proteins, amino acid and urea, albuminoidal nitrogen is an obsolescent analysis which measures part of the organic nitrogen .

2- ammonia nitrogen : as nitrogen ammonium salts or as free ammonia .

Ammonia is a form of nitrogen found in water and is usually expressed in terms of mg/l . free ammonia which is the same as free saline ammonia or ammoniacal, nitrogen is the form most usually determined in water, it exists either in the free state or as saline ammonium ion depending upon pH value .

Ammoniacal compound are found in most natural waters, they originate from various sources, some of which are completely harmless. Deep well water which are of good organic quality may contain high levels of free ammonia caused by the reduction of nitrates either by bacteria or by the surrounding geological strata, however, ammonia can also indicate recent pollution of water body by either sewage or industrial effluent , the amount in raw water is of importance in determining chlorine doses for disinfection .

3-nitrite nitrogen : nitrites are found in natural water or an intermediate product in the nitrogen cycle .

Nitrite is an intermediate oxidation state of nitrogen in the biochemical oxidation of ammonia to nitrate and in the reduction of nitrates under conditions where there is deficit of oxygen. surface water unless badly polluted with sewage effluent, rarely contains more than 0.1 mg/l of nitrogen, thus the presence of nitrites in conjunction with high ammonia levels in surface waters generally indicates pollution from sewage or sewage effluent . whilst the presence of nitrites in ground water may be a sign of sewage pollution it may have no hygienic significance .

4-nitrate nitrogen : nitrate are normally present in natural drinking and waste water. nitrates enter water supplies from breakdown vegetation. it can be reduced in ground water to nitrite especially in areas of ferruginous sands.

Nitrate is the final stage of oxidation of ammonia and mineralization of nitrogen from organic matter. most of this oxidation in soil and water is achieved by nitrify bacteria and can only occur in a well oxygenated environment^[7].

WHO's drinking water standards 1993

WHO's Guidelines for Drinking-water Quality, set up in Geneva, 1993, are the international reference point for standard setting and drinking-water safety.

Element/ substance	Symbol/ formula	Normally found in fresh water/surface water/ground water	Health based guideline by the WHO
Aluminium	Al		0.2 mg/l
Ammonia	NH ₄	< 0.2 mg/l (up to 0.3 mg/l in anaerobic waters)	No guideline
Antimony	Sb	< 4 µg/l	0.005 mg/l
Arsenic	As		0.01 mg/l
Asbestos			No guideline
Barium	Ba		0.3 mg/l
Berillium	Be	< 1 µg/l	No guideline
Boron	B	< 1 mg/l	0.3 mg/l
Cadmium	Cd	< 1 µg/l	0.003 mg/l
Chloride	Cl		250 mg/l
Chromium	Cr ³⁺ , Cr ⁶⁺	< 2 µg/l	0.05 mg/l
Colour			Not mentioned
Copper	Cu		2 mg/l
Cyanide	CN ⁻		0.07 mg/l
Dissolved oxygen	O ₂		No guideline
Fluoride	F	< 1.5 mg/l (up to 10)	1.5 mg/l
Hardness	mg/l		No guideline

	CaCO ₃		
Hydrogen sulfide	H ₂ S		No guideline
Iron	Fe	0.5 - 50 mg/l	No guideline
Lead	Pb		0.01 mg/l
Manganese	Mn		0.5 mg/l
Mercury	Hg	< 0.5 µg/l	0.001 mg/l
Molybdenum	Mb	< 0.01 mg/l	0.07 mg/l
Nickel	Ni	< 0.02 mg/l	0.02 mg/l
Nitrate and nitrite	NO ₃ , NO ₂		50 mg/l total nitrogen
Turbidity			Not mentioned
pH			No guideline
Selenium	Se	<< 0.01 mg/l	0.01 mg/l
Silver	Ag	5 – 50 µg/l	No guideline
Sodium	Na	< 20 mg/l	200 mg/l
Sulfate	SO ₄		500 mg/l
Inorganic tin	Sn		No guideline
TDS			No guideline
Uranium	U		1.4 mg/l
Zinc	Zn		3 mg/l

Group	Substance	Formula	Health based guideline by the WHO
Chlorinated alkanes	Carbon tetrachloride	C Cl ₄	2 µg/l
	Dichloromethane	C H ₂ Cl ₂	20 µg/l
	1,1-Dichloroethane	C ₂ H ₄ Cl ₂	No guideline
	1,2-Dichloroethane	Cl CH ₂ CH ₂ Cl	30 µg/l
	1,1,1-Trichloroethane	CH ₃ C Cl ₃	2000 µg/l
Chlorinated ethenes	1,1-Dichloroethene	C ₂ H ₂ Cl ₂	30 µg/l
	1,2-Dichloroethene	C ₂ H ₂ Cl ₂	50 µg/l

	Trichloroethene		$C_2 H Cl_3$	70 $\mu g/l$
	Tetrachloroethene		$C_2 Cl_4$	40 $\mu g/l$
Aromatic hydrocarbons	Benzene		$C_6 H_6$	10 $\mu g/l$
	Toluene		$C_7 H_8$	700 $\mu g/l$
	Xylenes		$C_8 H_{10}$	500 $\mu g/l$
	Ethylbenzene		$C_8 H_{10}$	300 $\mu g/l$
	Styrene		$C_8 H_8$	20 $\mu g/l$
	Polynuclear Aromatic Hydrocarbons (PAHs)		$C_2 H_3 N_1 O_5$ P_{13}	0.7 $\mu g/l$
	Chlorinated benzenes	Monochlorobenzene (MCB)		$C_6 H_5 Cl$
Dichlorobenzenes (DCBs)		1,2-Dichlorobenzene (1,2-DCB)	$C_6 H_4 Cl_2$	1000 $\mu g/l$
		1,3-Dichlorobenzene (1,3-DCB)	$C_6 H_4 Cl_2$	No guideline
		1,4-Dichlorobenzene (1,4-DCB)	$C_6 H_4 Cl_2$	300 $\mu g/l$
Trichlorobenzenes (TCBs)		$C_6 H_3 Cl_3$	20 $\mu g/l$	
Miscellaneous organic constituent	Di(2-ethylhexyl)adipate (DEHA)		$C_{22} H_{42} O_4$	80 $\mu g/l$
	Di(2-ethylhexyl)phthalate (DEHP)		$C_{24} H_{38} O_4$	8 $\mu g/l$
	Acrylamide		$C_3 H_5 N O$	0.5 $\mu g/l$
	Epichlorohydrin (ECH)		$C_3 H_5 Cl O$	0.4 $\mu g/l$
	Hexachlorobutadiene (HCBd)		$C_4 Cl_6$	0.6 $\mu g/l$
	Ethylenediaminetetraacetic acid (EDTA)		$C_{10} H_{12} N_2 O_8$	200 $\mu g/l$
	Nitrilotriacetic acid (NTA)		$N(CH_2COOH)_3$	200 $\mu g/l$
	Organotins	Dialkyltins	$R_2 Sn X_2$	No guideline
		Tributyl oxide (TBTO)	$C_{24} H_{54} O Sn_2$	2 $\mu g/l$

Substance	Formula	Health based guideline by the WHO	
Alachlor	$C_{14}H_{20}ClNO_2$	20 µg/l	
Aldicarb	$C_7H_{14}N_2O_4S$	10 µg/l	
Aldrin and dieldrin	$C_{12}H_8Cl_6$ $C_{12}H_8Cl_6O$	0.03 µg/l	
Atrazine	$C_8H_{14}ClN_5$	2 µg/l	
Bentazone	$C_{10}H_{12}N_2O_3S$	30 µg/l	
Carbofuran	$C_{12}H_{15}NO_3$	5 µg/l	
Chlordane	$C_{10}H_6Cl_8$	0.2 µg/l	
Chlorotoluron	$C_{10}H_{13}ClN_2O$	30 µg/l	
DDT	$C_{14}H_9Cl_5$	2 µg/l	
1,2-Dibromo-3-chloropropane	$C_3H_5Br_2Cl$	1 µg/l	
2,4-Dichlorophenoxyacetic acid (2,4-D)	$C_8H_6Cl_2O_3$	30 µg/l	
1,2-Dichloropropane	$C_3H_6Cl_2$	No guideline	
1,3-Dichloropropane	$C_3H_6Cl_2$	20 µg/l	
1,3-Dichloropropene	$CH_3CHClCH_2Cl$	No guideline	
Ethylene dibromide (EDB)	$BrCH_2CH_2Br$	No guideline	
Heptachlor and heptachlor epoxide	$C_{10}H_5Cl_7$	0.03 µg/l	
Hexachlorobenzene (HCB)	$C_{10}H_5Cl_7O$	1 µg/l	
Isoproturon	$C_{12}H_{18}N_2O$	9 µg/l	
Lindane	$C_6H_6Cl_6$	2 µg/l	
MCPA	$C_9H_9ClO_3$	2 µg/l	
Methoxychlor	$(C_6H_4OCH_3)_2CHCl_3$	20 µg/l	
Metolachlor	$C_{15}H_{22}ClNO_2$	10 µg/l	
Molinate	$C_9H_{17}NOS$	6 µg/l	
Pendimethalin	$C_{13}H_{19}O_4N_3$	20 µg/l	
Pentachlorophenol (PCP)	C_6HCl_5O	9 µg/l	
Permethrin	$C_{21}H_{20}Cl_2O_3$	20 µg/l	
Propanil	$C_9H_9Cl_2NO$	20 µg/l	
Pyridate	$C_{19}H_{23}ClN_2O_2S$	100 µg/l	
Simazine	$C_7H_{12}ClN_5$	2 µg/l	
Trifluralin	$C_{13}H_{16}F_3N_3O_4$	20 µg/l	
Chlorophenoxy herbicides (excluding 2,4-D and MCPA)	2,4-DB	$C_{10}H_{10}Cl_2O_3$	90 µg/l
	Dichlorprop	$C_9H_8Cl_2O_3$	100 µg/l
	Fenoprop	$C_9H_7Cl_3O_3$	9 µg/l
	MCPB	$C_{11}H_{13}ClO_3$	No guideline

	Mecoprop	$C_{10}H_{11}ClO_3$	10 $\mu\text{g/l}$
	2,4,5-T	$C_8 H_5 Cl_3 O_3$	9 $\mu\text{g/l}$

Group	Substance		Formula	Health based guideline by the WHO
Disinfectants	Chloramines		$NH_nCl^{(3-n)}$, where $n = 0, 1$ or 2	3 mg/l
	Chlorine		Cl_2	5 mg/l
	Chlorine dioxide		ClO_2	No guideline
	Iodine		I_2	No guideline
Disinfectant by-products	Bromate		$Br O_3^-$	25 $\mu\text{g/l}$
	Chlorate		$Cl O_3^-$	No guideline
	Chlorite		$Cl O_2^-$	200 $\mu\text{g/l}$
	Chlorophenols	2-Chlorophenol (2-CP)	$C_6 H_5 Cl O$	No guideline
		2,4-Dichlorophenol (2,4-DCP)	$C_6 H_4 Cl_2 O$	No guideline
		2,4,6-Trichlorophenol (2,4,6-TCP)	$C_6 H_3 Cl_3 O$	200 $\mu\text{g/l}$
	Formaldehyde		HCHO	900 $\mu\text{g/l}$
	MX (3-Chloro-4-dichloromethyl-5-hydroxy-2(5H)-furanone)		$C_5 H_3 Cl_3 O_3$	No guideline
Trihalomethane	Bromoform	$C H Br_3$	100 $\mu\text{g/l}$	

	s	Dibromochloromethane	CH Br ₂ Cl	100 µg/l
		Bromodichloromethane	CH Br Cl ₂	60 µg/l
		Chloroform	CH Cl ₃	200 µg/l
	Chlorinated acetic acids	Monochloroacetic acid	C ₂ H ₃ Cl O ₂	No guideline
		Dichloroacetic acid	C ₂ H ₂ Cl ₂ O ₂	50 µg/l
		Trichloroacetic acid	C ₂ H Cl ₃ O ₂	100 µg/l
	Chloral hydrate (trichloroacetaldehyde)		C Cl ₃ CH(OH) 2	10 µg/l
	Chloroacetones		C ₃ H ₅ O Cl	No guideline
	Halogenated acetonitriles	Dichloroacetonitrile	C ₂ H Cl ₂ N	90 µg/l
		Dibromoacetonitrile	C ₂ H Br ₂ N	100 µg/l
		Bromochloroacetonitrile	CH Cl ₂ CN	No guideline
		Trichloroacetonitrile	C ₂ Cl ₃ N	1 µg/l
	Cyanogen chloride		Cl CN	70 µg/l
	Chloropicrin		C Cl ₃ NO ₂	No guideline

2. MATERIALS AND METHODS

2.1. Materials:

2.1.1. Sampling:

Three samples of water were collected from Elsemehin different dates and times, and stored in reagent bottles (1 liter).

Table (2.1): Collection of samples:

Sample No.	Area of collection	Date of collection	Time of collection
1	A	25/4/2014	8 AM
2	B	27/4/2014	8 AM
3	C	29/4/2014	8 AM

2.1.2. Apparatus:

- pH meter, 211 microprocessor.
- Electrical conductivity (EC), 4510.
- Turbidity meter, wag-WT3020.
- Digital flame photometer, models PFP7&PFP7/C.
- Digital balance.
- Spectrophotometer.

2.1.3. Reagents:

2.1.3.1. Hydrochloric acid (1:1).

2.1.3.2. Hydrochloric acid (concentrated).

2.1.4. Preparation of standards.

2.1.5. De ionized water.

- Standard buffer solution of pH 4,7 and 10:

Standard buffer solution of pH 4, 7, and 10 were prepared by dissolving tablets of pH 4, 7 and 10 in distilled water, and diluted to 100 ml.

- Standard potassium chloride (0.01M):

1.907g of AR KCl were dissolved and diluted to 1 liter with de ionized water to make standard reference solution

- HCl (1:1):

25 ml distilled water were added to 25 ml concentrated HCl.

- Eriochrome Black T indicator (solid):

1 tablet of Eriochrome Black T (Total Hardness tablet) was used for 50 ml sample.

- Standard EDTA titrant (0.01 M):

3.723g disodium EDTA salt ($\text{Na}_2\text{N}_2\text{C}_{10}\text{H}_{14}\text{O}_8$) were dissolved and diluted to 1 liter with distilled water.

- Standard calcium solution (0.01 M):

1.00g of AR anhydrous CaCO_3 was dissolved by adding a little of 1:1 HCl until CaCO_3 had dissolved, 200 ml of water were added and the solution was boiled for a few minutes to expell CO_2 . Cooled, a few drops of methyl

orange indicator were added, and the intermediate orange colour was adjusted by adding a few drops of 1:1 HCl. The solution was transferred quantitatively to 1000 ml volumetric flask and diluted with distilled water.

- Potassium chromate (5%):

5.0g of AR K_2CrO_4 were dissolved in distilled water, few drops of silver nitrate ($AgNO_3$) were added until a red precipitate was formed, the solution was filtered and diluted to 100 ml with distilled water.

- Silver nitrate titrant (0.028 M):

4.792g of $AgNO_3$ were dissolved in distilled water and diluted to 1 liter. The resulting solution was stored in a dark bottle.

- Sodium carbonate solution (0.025M):

2.25g of AR Na_2CO_3 were dissolved in distilled water and transferred to 1 liter volumetric flask, the flask was filled to the mark with distilled water.

- Standard Hydrochloric acid (0.1M):

9.0 ml concentrated HCl were diluted to 1 liter with distilled water.

- Phenolphthalein indicator solution:

0.5g of Phenolphthalein was dissolved in 50 ml with 95% ethanol and diluted to 100 ml.

- Methyl orange indicator solution:

0.05g of methyl orange (powder) was dissolved in distilled water and diluted to 100 ml.

- Stock sodium solution:

2.54g of NaCl were dried at 140°C, dissolved in distilled water and diluted to 1000 ml to give 1000 ppm Na solution.

- Standard sodium solutions:

Standard sodium solutions were prepared from the stock sodium solution by taking the following volumes and diluted to 100 ml with distilled water : 1, 1.5, 2.5, 5, 7.5, 9 ml, to give 10, 15, 25, 50, 75, 90 ppm respectively.

- Stock potassium solution:

1.907g of AR KCl were dried at 110 °C, dissolved and diluted to 1000 ml with distilled water to give 1000 ppm K solution.

- Standard potassium solutions:

Standard potassium solutions were prepared from the stock potassium solution by taking the following volumes and diluted to 100 ml with distilled water : 0.5, 1, 1.5, 2.5, 5, 7.5, ml, to give 5, 10, 15, 25, 50, 75 ppm respectively.

2.2. Methods:

2.2.1. pH:

The pH - meter was calibrated by using buffer solutions of pH 4, 7 and 10 (preparation of the buffer solutions by dissolving buffer tablets of pH 4, 7 and 10 in 100 ml distilled water) 50 ml of each water sample was placed in a 100 ml beaker, then the temperature was adjusted to 25c the cell was rinsed with distilled water and inserted into the water sample, the reading was recorded.

2.2.2. Electrical Conductivity (EC):

The cell was rinsed thoroughly with deionised water, then rinsed with KCl solution (0.01M), 50 ml of each water sample was placed in a 100ml beaker, then the temperature was adjusted to 25c, the cell was rinsed with deionised water and inserted into the water sample, the reading was recorded.

2.2.3. Total Dissolved Solids (TDS) :

250 ml of water sample were transferred to a dry weighed beaker. The water was boiled until dryness.

Then the beaker containing the dried salts was weighed.

The TDS was calculated by using the following formula:

$$\text{TDS(mg/L)} = A - B \times 1000 \times 4$$

Where :

A = weight of dried beaker with salt residue.

B = weight of empty beaker.

4 = Dilution factor

2.2.4. Total Suspended Solids (TSS):

250 ml of water sample were filtered by using dried and weighed sintered crucible glass. Then the crucible was dried in an oven at 110 °C for 3 hrs.

This procedure was repeated till a constant weight was obtained. The TSS was calculated by using the following formula:

$$\text{TSS (mg/L)} = A - B \times 1000 \times 4$$

Where :

A = weight of crucible with the dried residue.

B = weight of empty crucible.

4 = Dilution factor.

2.2.5 Turbidity:

The turbidity of water samples was determined by using Wag-WT 3020 Turbidity meter.

2.2.6. Hardness:

50 ml of each sample in 250ml conical flask, 2 ml buffer solution (pH=10) and 1 tablet of hardness indicator were added, then the solution was titrated with (0.01M) EDTA solution with continuous stirring until the reddish colour change in to the blue at the end point.

$$\text{Hardness as mg/L } CaCO_3 = \frac{A \times B \times 1000}{V}$$

Where:

A= mls of EDTA required for titration.

B= mg of CaCO₃ equivalent to 1.00 ml EDTA titrant.

V= mls of sample.

$$\text{Where for hardness} = \frac{V \times 0.01 \times 100 \times 1000}{50}$$

V=volume of EDTA required for titration.

2.2.7. Chloride:

50.00 ml of each water sample in 250 ml conical flask, 1.00 ml of K_2CrO_4 indicator was added, then the solution was titrated with (0.014 M) $AgNO_3$ solution ($AgNO_3$ solution was standardized by Mohr method using standard KCl solution) until a pinkish yellow precipitation was produced. The distilled water being used as a blank was treated in the same manner.

$$Cl^- \text{ mg/L} = \frac{(A-B) \times M \times 35.5 \times 1000}{V}$$

Where:

A = mls of $AgNO_3$ required for titration.

B = mls of titrate for the blank.

2.2.8: Iron:

10 ml of water sample were placed in 50 ml conical flask then 0.28 g of 1.10 phenanthroline reagent was added to the flask and content was mixed for three minutes. The concentration of 10 ml of mixture was determined by using 5 cm glass cell at wavelength 510 nm in the presence of a blank .and the result was recorded.

2.2.9. Carbonate and bicarbonate:

50.00 ml of each water sample were titrated with (0.05M) HCl (HCl was standardized by standard sodium carbonate solution) using phenolphthalein indicator, the titrate volume (x) was recorded. Another 50.00 mls of the sample were titrated with standard (0.05M) HCl using methyl orange

indicator, until the colour change from orange to red. The titrate volume (y) was recorded.

X= volume of acid = 1/2 carbonate.

There for:

2X= volume of acid required to titrate all the carbonate in 50.00 ml sample.

Y= volume of acid \equiv all carbonate + all bicarbonate.

Therefore:

Y – 2X = volume of acid \equiv bicarbonate in 50.00 ml sample.

2.2.10. Calcium:

50.00 ml of water sample were placed in 250 ml conical flask, the pH was adjusted to 12-13 by addition of 2.0 ml of NaOH, one tablet of murexide indicator was added, while stirring, the solution was then titrated with EDTA solution until the colour change from pink to purple.

$$\text{Ca}^{2+} \text{ mg/L} = \frac{A \times B \times 1000}{V}$$

Where:

A = mls of titrant.

B = mg of CaCO₃ equivalent to 1.00 ml EDTA titrant.

V = mls of sample.

2. 2.11. Potassium and Sodium:

10.00 ml of each water sample were diluted to 100 ml, and then the concentration of sodium and potassium were determined by flame photometric method.

$$K^+ \text{ or } Na^+ \text{ mg/L} = A \times 10$$

Where:

A = reading from the instrument.

10 = dilution factor.

2.2.12: Sulphate

50 ml of the water samples were placed in 250 ml beakers, diluted by distilled water to 100 ml and heated to boiling.

A diluted solution of barium chloride was added till a precipitate formed with no further precipitation with addition of barium chloride.

The precipitates from the three samples were filtered using ashless filter paper, and then transferred to previously dried and weighed crucibles, the crucibles containing the precipitate were burned completely in burner flame before they were transferred to an oven and ignited at 800°C for about 15 minutes.

The crucibles were cooled in desiccators and weighed to find the weight of the barium sulphate precipitated from each water sample.

2.2.13: Nitrite:

Aluminium hydroxide was added to 100 ml sample with mixing, and filtering, 1ml of 1M hydrochloric acid was added to 50 ml of sample. The wavelength of UV spectrophotometer was set a 220 nm. The device was calibrated against distilled water to zero absorbance, followed by calibration against standard nitrite solutions.

The calibration curve was established. The sample absorbance was measured.

3. Result and discussion

3.1. Results:

3.1.1. Results of pH, EC, TDS, TSS and turbidity:

Table (3. 1): The pH , EC, TDS, TSS and turbidity

Sample No.	location	pH	EC in μs	TDS in ppm	TSS in Ppm	Turbidity in NTU
1	A	7.06	177.9	106.74	298	26.8
2	B	7.06	177.0	106.2	298	14.7
3	C	6.93	170.0	102.0	296.5	30.2

3.1.2. Results of concentration of dissolved species:

Table (3. 2) Hardness, Chloride, Iodide, Carbonate and Bicarbonate

Sample No.	Location	Hardness As CaCO_3	Carbonate and Bicarbonate	Cl^- in mg/l	NO_3^{2-} In mg/l	Iron in mg/l	Sulphate in mg/l
1	A	88	—	15.9	4.2	0.04	4.00
2	B	90	—	13.92	2.9	0.01	3.00
3	C	80	—	17.89	3.9	0.01	3.00

3.1.3. Results of concentration of sodium and potassium

Table (3. 3) Sodium and potassium

Sample No.	Location	Sodium in Ppm	Potassium in Ppm	Calcium in Ppm
1	A	26	22.5	72.5
2	B	17.5	28.5	72.5
3	C	20	30.5	62.5

3. 2. Discussion:

In this dissertation the physical and chemical parameters in three samples of water were determined.

3.2.1. pH:

The results of pH showed that all the samples are neutral.

3.2.2. Electrical Conductivity (EC):

All samples gave reading within the standards of WHO.

3.2.3. Total Dissolved Solids (TDS):

The results of TDS showed that all the samples were in agreement with the accepted moderate values of WHO.

3.2.4. Total suspended solids (TSS):

The results of TSS showed that all the samples were in agreement with the accepted moderate values of WHO.

3.2.5. Turbidity:

The results of turbidity obtained exceed the standards of WHO

3.2.6. Hardness:

The results of hardness in table(3.2.) showed that all samples agree with the WHO maximum permissible values for drinking water .

3.2.7. Chloride:

The results of Chloride concentration obtained are within the standards of WHO.

3.2.8. Carbonate and bicarbonate:

The concentration of Carbonate and bicarbonate in all the studied samples can not be measured by classical method.

3.2.9. Sodium and potassium:

The results of sodium showed that all samples agree with the accepted maximum values of WHO, But potassium ion concentration exceeds the value recommended by WHO.

3.2.10. Calcium:

The concentration of calcium shows that these values are within the permissible standards of WHO.

3.2.11. Iron:

The concentration of iron showed that these values with in the permissible Standards of WHO.

3.2.12. Nitrate:

The concentration of nitrate showed that these values with in the permissible

Standards of WHO.

3.2.13. Sulphate:

The concentration of sulphate showed that these values with in the permissible

Standards of WHO.

3. Conclusion:

From the previous result the samples showed approximately same concentrations of various kinds of dissolved species.

All samples are neutral, and have high values of total suspended solids (TSS) with high turbidity, so the surface water (Elsemeih region) must be treated by filtration to remove the Total suspended solids, and also must be treated for turbidity removal e.g filtration and chlorine treatment.

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