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PHYSICOCHEMICAL STUDIES ON THE SURFACE WATER OF RIVER NILE AND ITS CANALS

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Abstract

The study of surface water chemistry mainly based on the results of the chemical analysis which carried out for the thirty-nine (39) collected water samples. The analysis includes the determination of the different properties of water such as electric conductivity(EC), hydrogen ion concentration (pH), total dissolved salts (TDS), turbidity , major ions as cations (Ca^{2+}, Mg^{2+},Na^{+}, K^{+}),anions (CO_3^{2-},HCO_3^{-} ,SO_4^{2-},Cl^{-}) together with some minor and trace components as PO_4^{3-},NO_3^{-},Pb^{2+},Cd^{2+},Sr^{2+} . Based on the chemical analysis data of surface water of the main irrigation system (River Nile and its Canals) the conclusions could be outlined as follows: Water salinity, Distribution of total water hardness, Distribution of major ions Hydro chemical coefficients, Hypothetical salts assemblages.

Introduction

Nitrate, ammonium, and chloride are measured in-line using appropriate ion selective electrodes (ISEs), the results obtained being compared with those provided by the corresponding reference methods. Recovery analyses with (ISEs) and standard methods, study of interferences, and evaluation of major sensor features have also been carried out, (1).

A multivariate assessment has been adapted to the classification of a large, irregular dataset of approximately 34,000 surface water samples accumulated over more than 30 years. A two-stage K-means clustering method which designed to analyze chemical data in the form of percentages of major ions (Na^{+}, Mg^{2+}, Ca^{2+}, Cl^{-} , HCO_3^{-} and SO_4^{2}); the first stage of clustering produced 347 groups, which were then re-clustered to generatethe final nine water types, (2).

The statistical study demonstrated that flavored waters generally have increased contents of (K^{+}, Na^{+}, Fe^{3+} and Cu^{2+}). The added preservatives also led to significant differences in the mineral composition. Acidifying agents and fruit juice can also be correlated to the increase of (Mg^{2+}, K^{+}, Na^{+}, Fe^{3+} and Cu^{2+}). Sweeteners do not provide any significant difference in (Ca^{2+}, Mg^{2+}, Fe^{3+} and Zn^{2+}) contents, (3).

The present study investigated the effect of water cationic composition (Ca^{2+}, Mg^{2+}, Na^{+}, pH) on the bioaccumulation and elimination rates of copper by an aquatic moss (Fontinalisantipyretica), under laboratory conditions. For this purpose, mosses were exposed to copper at an environmentally relevant and usually non-toxic concentration (5 μg L^{-1}) in natural waters where cationic composition and concentrations were varied, (4).

For many surface waters, generation of acid neutralizing capacity is closely linked to the cycles of (Ca^{2+}, Mg^{2+}, and Na^{+}), whereas cycling of the critical nutrient P may be strongly influenced by the biogeochemistry of (Al^{3+}). Despite wide variations in the concentrations of major cations in different surface water systems, several consistent chemical patterns havebeen observed, (5).

The determination of hardness of water is a useful parameter to control the quality of water for households and industrial uses. The present work suggests a new methodology as an alternative to the conventional EDTA titration. The determination of (Ca^{2+} and Mg^{2+}) is performed using two different coated piezoelectric quartz crystals. Poly(vinyl chloride) membranes, incorporating a plasticizer and a Mg or Caionophore were used to coat the piezoelectric quartz crystals, (6).

In this method a plot of electric conductivity(EC) against concurrent alkalinity data, which used to distinguish EC values for impacted or degraded streams from those that can be considered background values in a particular geologic setting. The method performs well in areas underlain by carbonate bedrock, as streams in those areas characteristically have EC values that are strongly correlated with alkalinity,(7).

Hydrochemical conditions up to depths of 1000 m below ground level around the Mizunami Underground Research Laboratory were investigated to construct a “baseline condition model” describing the undisturbed hydrochemical environment prior to excavation of the underground facilities at Mizunami, Gifu, Japan, (8).

The pH, ranged between 6.40 and 6.90 and registered a good water quality rating (WQ rating range: 72.73–87.02) for both raw and treated water. Raw water registered an overall medium water quality rating of 62.67%. Overall, 91.67% of the samples registered a good water quality rating (WQI range: 80.28–88.80%) and 8.33% registered a very good water quality rating (WQI = 90.07%), (9).

Lagoons of the Nile delta are a vital aqua cultural base for millions of people in Egypt. When the Aswan High Dam was completed, the estuary has changed from high to low turbidity and this has dramatically altered the eco-hydrological environment. In this study we attempt to explore the spatial and temporal distribution of heavy metals (Al^{3+}, Cd^{2+}, Cr^{3+}, Cu^{2+}, Fe^{3+}, Mn^{2+}, Ni^{2+}, Pb^{2+} and Zn^{2+}) based on 6 short sediment cores recovered from Manzala, Burullus and Edku lagoons on the Nile delta, (10).

Radiometric dating indicates that the upper 10–15 cm of the core sediment is post-Aswan Dam. Manzala on the eastern delta coast is severely polluted by almost all metals analyzed in the present study, especially Mn^{2+}, Pb^{2+}, Zn^{2+} and Cd^{2+}, due to its connection to the city of Cairo, and the direct human input from neighboring megacities, where the petro-chemical industry is thought to be a major source, (10).

Levels of the heavy metals Copper (Cu^{2+}), Zinc (Zn^{2+}), Lead (Pb^{2+}), Cadmium (Cd^{2+}), Chromium (Cr^{2+}), Nickel (Ni^{2+}), Iron (Fe^{3+}) and Manganese (Mn^{2+}) were determined in coastal water, sediments and soft tissues of the gastropod limpet, Patella caerulea, and the bivalve, Barbatusbarbatus, from seven different stations in the western coast of the Gulf of Suez, (11).

Experimental part

Measurements of the constituents of surface water samples:

These measurements contain the following topics:

- **Hydrogen ion concentration (pH):**

The pH value of a solution is the negative logarithm of the concentration of hydrogen ions in moles per liter - log $[H^+]$. The pH value is determined by measuring the electrical potential of a glass hydrogen ion electrode against a reference electrode of known potential and this is undertaken by means of pH-meter, WTW model LF 538.

- **Specific electrical conductance(EC):**

The specific electrical conductance (conductivity) and the specific electrical resistance (resistivity) measure the ability of a medium to the passage of electricity. Resistivity is the reciprocal of conductivity. EC of water is determined by means of an electrical conductivity meter, Model 35, Yellow Springs Instrument Company, U.S.A. The EC is expressed in micromhos per centimeter (µs) at 25°C. EC is considered as a function of the total dissolved solids (TDS), and expressed in milligrams per liter (mg/l = ppm).

- **Total dissolved solids (TDS):**

Total dissolved solids for water sample can be determined using one of the following methods:

- **Evaporation method:**

In this method a certain volume of sample (500ml maximum) is pipette to into a dish. Then the sample was undergoing to evaporation just to dryness on a steam bath. Dry in the oven at 180°C for one hr.. Cool in a desiccator and immediately weight, record the weight to the nearest 0.0001mg.

$$\text{Dissolved solids (ppm)} = \frac{(1 \times 1000 \times \text{mg residue})}{\text{Density} \times \text{ml sample}}$$

- **Calculation method:**

  In This method TDS in ppm can be determined as follow;

$$TDS= [Ca^{2+}]+[Mg^{2+}]+[Na^{+}]+[K^{+}]+[CO_3^{2-}]+[1/2\ HCO_3^{-}]+[SO_4^{2-}]+[Cl^{-}].$$

- **Carbonate and bicarbonate constituents:**

  Carbonate (CO_3^{2-}) and bicarbonate (HCO_3^{-}) constituents are determined titrimetrically against sulfuric acid by neutralization method.

  Pipet a volume of sample into a porcelain dish and add one drop of phenolphthalein, if solution turns pink, titrate against sulphuric acid (0.01N) from a burretdropwise until the colour just disappears, and designate this burret reading as (y) and add 2 drops of methyl orange and titrates against sulphuric acid 0.01N to the just orange colour, designate the new burret reading as (z).

- **Calcium and magnesium constituents:**

  Calcium (Ca^{2+}) and magnesium (Mg^{2+}) concentrations are determined titrimetrically against (Na_2EDTA) by complexometric method, calcium is determined by using murexid indicator while magnesium is estimated by subtracting the calcium value from the total hardness value after determining them using Eriochrome Black T in presence of suitable buffer solution.

- **Total hardness (calcium and magnesium hardness:**

  Pipet a volume of sample into a porcelain dish and add 1ml (3%) NH_2OH. and add 1ml buffer solution andadd 2ml Eriochrome black T indicator and titrate with Na_2EDTA (1.00ml=1.00mg $CaCO_3$) until the colour of the solution becomes clear blue.

- **Calcium hardness.**

  Pipet a volume of sample into a porcelain dish and add1ml NaOH solution and add 0.2g murexid indicator or 5 drops and add the titrant (Na_2EDTA) slowly with continuous stirring until the colour changes from pink to purple.

- **Magnesium hardness:**

  Mg^{2+} hardness (in ppm) as $MgCO_3$ = total hardness - calcium hardness.

- **Chloride constituent:**

  Chloride is determined volumetrically by titration against silver nitrate using potassium chromate as indicator.

Pipet a volume of sample containing less than 50mg Cl^- into a porcelain dish and add 10 drops K_2CrO_4 indicator andwith continuous stirring titrates with $AgNO_3$ until the pink-red Ag_2CrO_4 persists for 10-15sec.

- **Sodium and potassium constituents:**

Sodium (Na^+) and potassium (K^+) constituents are determined by means of flame photometer model PFP 7, Jenway, (UK). The obtained standard curve and the sample readings can be calculated in ppm (less than 100ppm).

- **Sodium constituent:**

Measure the blank and the standards of Na^+ ppm by the flame photometer and record the readings and measure the samples containing less than 100ppm Na^+ and record the readings.

- **Potassium constituent:**

Measure the blank and the standards of K^+ ppm by the flame photometer and record the readings andmeasure the samples containing less than 100ppm K^+ and record the readings.

- **Sulfate constituent:**

Sulfates (SO_4^{2-}) are determined by the turbidity method using spectrophotometer single beam, model (20D), Milton Roy Company, U.S.A. To every 10ml of the blank and the standards add 5ml of acid salt and few crystals of barium chloride and measure transmitance at wavelength 420nm and in a semi-logarithmic paper plots a relation between the standards concentrations and %T and from the plot, the sample reading can be obtained at concentrations less than 50ppm SO_4^{2-}.

- **Phosphate constituent:**

Phosphates, (PO_4^{3-}) are determined calorimetricallyby phosphor molybdate method by using UV/visible spectrophotometer, Unicam; model UV4-200.

To 50ml of blank, standard or samples add 10ml combined reagent, after 10minutes and before 30minutes measure absorbencies at wavelength 700 or 880nm andmeasure the phosphate standards and the test samples absorbencies against the blank and plot the absorbencies of the phosphate standards containing known amounts of constituents.

- **Heavy metals analysis:**

The heavy metals including Aluminum (Al^{3+}), iron (Fe^{3+}), manganese (Mn^{2+}), lead (Pb^{2+}), and Boron (B^{3+}) are determined by means of Inductive Coupled Plasma (ICP-MS), using 1000 ppm Multi- elements stock solution for standard preparation.

Results And Discussion

General outlines:

The water resources in the investigated area are surface water which contain River Nile along Egypt from south to north (Aswan to Rosetta and Damietta branches), some of the main canals such as El-klabiah, Abrahamia, Ismailia, El RiahEltawfiky,El-Mansourieh,Elmahmudia canals, Figs.(1)

The study of the surface water chemistry and its relation to the prevailing hydrogeological and environmental conditions is the main target of the present work. The chemical composition of surface water is the combined result of the water constituents that passes into the surface water and reacts with main channels that may modify the water composition.

The study of surface water chemistry mainly based on the results of the chemical analysis which carried out for the collected water samples in the main channels of River Nile and its canals. Detailed chemical analysis of 39 surface water samplesFigs.(1), representing all the different surface water in the study area were carried out by the author in the laboratories of researches in Cairo Drinking Water Company and hydrochemistry department of Desert Research Center (DRC). Such water samples were collected and analyzed for one period (November to december.2010) to evaluate such water for drinking, irrigation and different purposes.

The chemical analyses were carried out according to the methods adopted by the United States Geological Survey "Methods for collection and analysis of water samples ",USA and methods of determination of inorganic substances in water and fluvial sediments "Methods for determination of inorganic substances in water and fluvial sediments ",USA andAmerican Society for Testing and Materials, (12). The analyses include the determination of the different properties of water such as Turbidity test, EC, pH, TDS, major ions as Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, CO_3^{2-}, HCO_3^{-}, SO_4^{2-} and Cl^{-} together with some minor and trace components as PO_4^{3-}, NO_3^{-} Pb^{2+}, Cd^{2+} and Sr^{2+}. The obtained chemical data are expressed in milligram per liter or parts per million (ppm), milliequivalents per liter (me/l) or equivalents per million (epm) and percentage reacting values (epm %).In this chapter, the hydrogeochemical aspect is discussed under the Surface water chemistry.

Surface water chemistry:

Water salinity:

According to"Metamorphism of natural waters in the crust of weathering", London. The natural water is classified intothree main categories of total salinity;

fresh water (TDS up to 1500mg/l, μ=0.01-0.03); brackish water (1500 to 5000)mg/l, ionic strings (μ)=0.03-0.1) and saline water (TDS more than 5000mg/l, μ more than(0.1).

Twenty two water (22) samples (Fig.1) were collected from the River Nile, Eleven water (11) samples (Fig.1) were collected from the canals, six water (6) samples (Fig.1) were collected from the River Nile which mixed with sea water to interpret the variations in total salinity and ion behaviors. The chemical data of surface water, reveal that water salinity of River Nile varies from 129mg/l to 333 mg/l., Also the canals varies from 148 mg/l to 700 mg/l (Table 1).

The total salinity and major ions concentrations of the collected surface water samples vary from one locality to another depending on several factors (e.g., the beginning or the end of the Nile river, the length of the canal and, distance from the main feeding canals,……etc).Therefore, the surface water lies in the fresh water zone (Table, 1).

The water salinity of River Nile in the end of the branches Rosetta and Damietta which mixed with sea water (Mediterranean sea) varies from 11028 mg/l to 43016 mg/l.

Table (1): Frequency distribution of water salinity according to ionic strengthvalues for the different surface water in the study area.

Surface water type	Total samples	Fresh water (%) TDS<1500mg/l (μ=0.01-0.03)	saline water (%) TDS=>5000mg/l (μ=>0.1)	Whole surface water (mg/l)	
				Range	Mean
Surface water					
Nile	22	100%	0.00	129-333	231
Canals	11	100%	0.00	148-700	424
Mixed*	6	0.00	100%	11028-43016	27022

*Mixed is the water between Nile River and Mediterranean Sea.

Distribution of total water hardness:

The solubility of calcium and magnesium salts in natural waters is responsible for the so-called “water hardness”. Actually the total hardness in the natural water occurs due to the different types of salts. Very few of them (e.g., $CaSO_4$ salt) are of lagoonal origin and others (e.g., $MgCl_2$ salt) are of marine origin.

Generally, hardness is measured as $CaCO_3$ hardness or total hardness (TH). Carbonate hardness (CH) or temporary hardness is equivalent to the bicarbonate and carbonate (alkalinity). If the total hardness exceeds the alkalinity in equivalent parts per million (epm), the excess is termed non-carbonate hardness (NCH) or permanent hardness, while if it is less than or equal to the alkalinity, the permanent hardness =zero, “Chemistry of water and water pollution”, London. The temporary hardness can be removed by heating, where $CaCO_3$ precipitates while the permanent hardness can also, removed by adding sodium carbonate ($NaCO_3$. $10H_2O$), where $CaCO_3$ also precipitates.

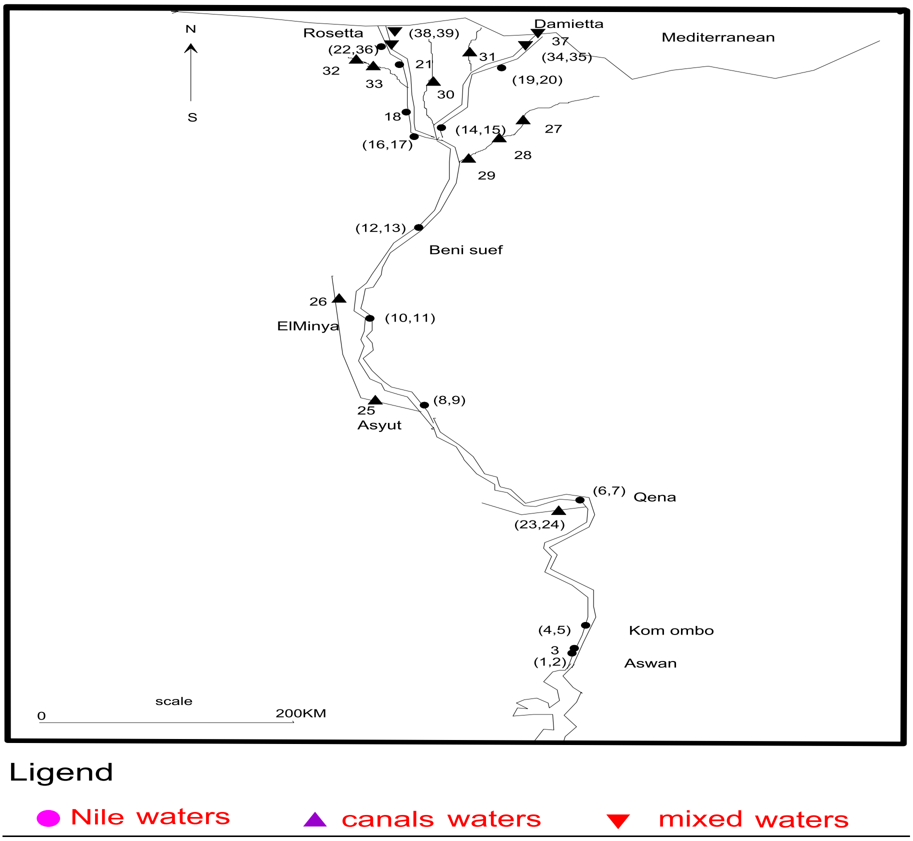

Fig.(1) Location map of water samples in Nile river and its canals (November 2011) ,Egypt

According to the chemical analysis of the Nile, canals and mixed(Nile +Sea) water samples, it is clear that the mean value of total, temporary and permanent hardness reaches (131, 115 ,16), (145, 121, 24) and (4726, 140, 4586) mg/l as $CaCO_3$, respectively. Noteworthy to mention that the Nile and canals water samples nearly have the same values of total, temporary and permanent hardness .Also,the temporary hardness relative to total hardness in the fresh water is more than that highly saline water and vice versa in permanent hardness relative to total hardness, (Table2).

These data indicate an increase in total, temporary and permanent hardness with increasing water salinity in all surface water samples according to the change of water type from fresh to saline water (table2). This is mainly attributed to the effect of leaching and dissolution of soluble salts leading to the increase of hardness with particular importance to the effect of NaCl concentration (effect of ionic strength) on increasing solubility of Ca^{2+} and Mg^{2+} in water. This does not exclude the contribution of CO_2, longer residence time, influence of salty water and cation exchange process.

With regard to total, permanent and temporary hardness relative to water salinity (TH/TDS, NCH/TDS and CH/TDS %) in the surface (Nile, Canals) and Mixed water samples, the obtained ratios are (71%, 5% and 66%), and (21%, 20% and 1%), respectively in the fresh to highly saline water type. This means that the total and temporary hardness percent of TDS decrease according to the change of water type from fresh to saline water, and vice versa in case of the permanent hardness. This is due to the increase in soluble salts of highly saline water samples (79 %), more than that of fresh water type (29%). This is confirmed by the rate of increasing of total hardness (35 folds) which is less than that of the water salinity (123 folds).

Undoubtedly, the increase in the water salinity of Nile and canals is due to the increase in readily soluble salts (NaCl, Na_2SO_4 and $NaHCO_3$) which is generally less than that of permanent and temporary hardness salts {$MgSO_4$,$CaSO_4$,$MgCl_2$, $Mg(HCO_3)_2$, and $Ca(HCO_3)_2$}, table (2). Therefore, the increase in water salinity is due to decrease of the soluble salts (29 % of TDS) is generally less than that of the temporary salts (66%ofTDS)anpermanentsalt (5%ofTDS) i.e.,(NaCl+Na_2SO_4+ $NaHCO_3$,29%)<{$Mg(HCO_3)_2$+$Ca(HCO_3)_2$,66%}<{$MgSO_4$+$CaSO_4$+$MgCl_2$, 5%} .

The increase in the water salinity of mixed water (Nile+ Sea) isoppositely with the trend of fresh water. Therefore, the increase in water salinity is due to increase of the soluble salts (79 % of TDS) is generally more than that of the permanent salt (20% of TDS) and temporarysalts (1%ofTDS)i.e., (NaCl,79%)>{$MgSO_4$+ $CaSO_4$+ $MgCl_2$,20}> {$Mg(HCO_3)_2$+$Ca(HCO_3)_2$,1}.

Table (2) Average and relative values of total, temporary and permanent hardness compared to the water salinity of surface water

<table>
<tr><th colspan="9">Surface water (Nile)</th></tr>
<tr><td>TDS mg/l</td><td>TH Mg/l</td><td>CH Mg/l</td><td>NCH mg/l</td><td>(TH/TDS)%</td><td>(CH/TDS)%</td><td>(CH/TH)%</td><td>(NCH/TDS)%</td><td>(NCH./TH)%</td></tr>
<tr><td>206</td><td>131</td><td>115</td><td>16</td><td>71</td><td>66</td><td>88</td><td>5</td><td>12</td></tr>
<tr><td colspan="9">Surface water (canals)</td></tr>
<tr><td>TDS mg/l</td><td>TH Mg/l</td><td>CH Mg/l</td><td>NCH mg/l</td><td>(TH/TDS)%</td><td>(CH/TDS)%</td><td>(CH/TH)%</td><td>(NCH/TDS)%</td><td>(NCH./TH)%</td></tr>
<tr><td>238</td><td>145</td><td>121</td><td>24</td><td>70</td><td>64</td><td>83</td><td>6</td><td>17</td></tr>
<tr><td colspan="9">Surface water (Nile and Canals)</td></tr>
<tr><td>TDS mg/l</td><td>TH Mg/l</td><td>CH Mg/l</td><td>NCH mg/l</td><td>(TH/TDS)%</td><td>(CH/TDS)%</td><td>(CH/TH)%</td><td>(NCH/TDS)%</td><td>(NCH./TH)%</td></tr>
<tr><td>217</td><td>136</td><td>117</td><td>19</td><td>71</td><td>66</td><td>86</td><td>5</td><td>14</td></tr>
<tr><td colspan="9">Surface water (Mixed)</td></tr>
<tr><td>TDS mg/l</td><td>TH Mg/l</td><td>CH Mg/l</td><td>NCH mg/l</td><td>(TH/TDS)%</td><td>(CH/TDS)%</td><td>(CH/TH)%</td><td>(NCH/TDS)%</td><td>(NCH./TH)%</td></tr>
<tr><td>26650</td><td>4726</td><td>140</td><td>4586</td><td>21</td><td>1</td><td>3</td><td>20</td><td>97</td></tr>
</table>

1- Carbonate hardness or temporary hardness relative to water salinity (CH% of TDS) = [Mg $(HCO_3)_2$ + Ca $(HCO_3)_2$] salts as percent.
2- Non-carbonate hardness or permanent hardness relative to water salinity (NCH% of TDS) = [$MgSO_4$ + $CaSO_4$ + $MgCl_2$] salts as percent.

IV.1.3-Distribution of major ions:-

The distribution of ions in surface water (Nile, canals and Mixed) in Egyptcan be discussed as follows;

From the distribution histograms of Nile and canals, the following are the main findings;

1-The frequency distribution of Na^+ and Cl^- for River Nile in the range of concentration (11.4-47.5 mg/l) (0.5-2.1me/l) and(9-59 mg/l)(0.25-1.66me/l), respectively. The canals water shows the range of concentration (13.9-58.7 mg/l) (0.6-2.55me/l) and (11-72 mg/l) (0.31-2.03me/l), respectively. The Mixed water shows the range of concentration (2600-11750 mg/l) (113.05-510.89me/l) and (4902-22200 mg/l) (138.23-626.04me/l), respectively. In River Nile water the majority Na^+ and Cl^- (28% and 19%) within the concentration (26.7mg/l) (1.16me/l) and (24mg/l) (0.65me/l), respectively. In Canals water The majority of Na^+ and Cl^- (29% and 21%) within the concentration (25.8mg/l) (1.12me/l) and (36mg/l)

(1me/l), respectively. In Mixed water The majority of Na^+ and Cl^- (77% and 89%) within the concentration (5700mg/l) (247.84me/l) and (10500mg/l) (296me/l), respectively This is expected because Na^+ often is accompanied with Cl^- to form NaCl salt.

2- The frequency distribution of Mg^{2+} and SO_4^{2-} for Nile waters shows two unequal categories within the range of concentration (6.72-17.76mg/l) (0.55-1.46 me/l) and (9.93-47.19 mg/l) (0.21-0.98me/l),canals water shows two unequal categories within the range of concentration (10.08-18.24mg/l) (0.83-1.5 me/l) and (16.36-49.69 mg/l) (0.54-1.03me/l) and Mixed water shows two unequal categories within the range of concentration (312-1512mg/l) (25.66-124.35 me/l) and (546.88-3725 mg/l) (11.38-77.48me/l). In River Nile water the majority of Mg^{2+} and SO_4^{2-} (23% and 13%) within the concentrations (8.16mg/l) (0.67me/l) and (20.25mg/l) (0.42me/l), respectively.In canals water the majority of Mg^{2+} and SO_4^{2-} (25% and 15%) within the concentration (14.88mg/l) (1.22me/l) and (28.34mg/l) (0.59me/l), respectively. In mixed water the majority of Mg^{2+} and SO_4^{2-} (16% and 9%) within the concentrations (1272mg/l) (104.6me/l) and (1471.88mg/l) (30.6me/l), respectively this is due to leaching and dissolution of sulphate minerals (terrestrial salts) as a result of water movement through the main channel of River Nile and its canals.

3- The frequency distribution of Ca^{2+} and $HCO_3^-$for Nile waters show two unequal categories within the range of concentration (26.4-48mg/l) (1.32-2.4 me/l) and (116-194 mg/l) (1.9-3.18me/l) ,Canals water shows two unequal categories within the range of concentration (28-45.6mg/l) (1.4-2.28 me/l) and (116-184 mg/l) (1.9-3.02me/l) and Mixed water shows two unequal categories within the range of concentration (160-520mg/l) (7.98-25.9 me/l) and (148-196 mg/l) (2.44-3.21me/l). For River Nile water samples the majority of Ca^{2+} and HCO_3^- (48% and 59%) within the concentration (34.4mg/l) (1.7me/l) and (140mg/l) (2.29me/l), respectively. In Canals water the majority of Ca^{2+} and HCO^-_3 (40% and 55%) within the concentrations (38.4mg/l) (1.9me/l) and (158mg/l) (2.59me/l), respectively. In Mixed water The majority of Mg^{2+} and SO_4^{2-} (4% and 1%) within the concentration (260mg/l) (12.98me/l) and (196mg/l) (3.21me/l), respectively This well agrees with the ion dominance of Ca^{2+} and HCO_3^- (Ca –HCO_3^- type) in Nile and canals.

From the distribution histograms of drain water, (Table 3). it is clear that the arithmetic mean values of different ions that predict the most effective ions affecting the salinity level, the obtained data of surface water (Nile, canals and mixed)shows that the affective ions that cause an increase of water salinity are in a descending order; In Nile waters(Ca^{2+}> Na^+> Mg^{2+}) as cations , (HCO_3^->Cl^->SO_4^{2-}) as anions. In canals water (Ca^{2+}>Na^+>Mg^{2+}), (Na^+> Ca^{2+}>Mg^{2+}),(Ca^{2+}> Mg^{2+}> Na^+) as cations,

($HCO_3^- > Cl^- > SO_4^{2-}$) ,($HCO_3^- > SO_4^{2-} > Cl^-$)as anions. In mixed water ($Na^+ > Mg^{2+} > Ca^{2+}$) as cations, ($Cl^- > SO_4^{2-} > HCO_3^-$)as anions, (Table3).

Table (3) Range and mean values of the major dissolved ions in the surface water.

Surface	Ca^{2+}	Mg^{2+}	Na^+	HCO^-_3	Cl^-	SO_4^{2-}	
Nile water	26.4-48	6.72-17.76	11.4-47.5	116-194	9-59	9.93-47.19	Range
	34	11	26	142	27	27	Mean
Canals water	28-45.6	10.08-	13.9-58.7	116-184	11-72	16.56-49.69	Range
	36	13	32	148	35	32	Mean
Mixed water	160-520	312-1512	2600-11750	148-196	4902-22200	546.88-3725	Range
	333	946	8108	171	14646	2228	Mean

Evaluation of the surface water for human drinking based on turbidity, water salinity and major ions:

Water used for human drinking should be colorless, free of turbidity, excessive amount of dissolved salts, unpleasant taste and odor; also harmful micro-organisms should be virtually absent.

Based on the permissible limit of turbidity, the majority of surface water samples (90%) are unsuitable for drinking except four samples (10%, at Aswan and KomOmbo) which are suitable because they have turbidity less than 1 Nephelometric Turbidity Unit (NTU), the suitability of the surface water sources for drinking according to water salinity and major ions was evaluated by comparison with the water quality guidelines), table (4). It is clear that the majority of surface water samples (85%), are suitable for human drinking, where they have water salinity ranges from 121 to 364 ppm. On the other hand, mixed water samples (15%), have salinity more than 1200 mg/l, so they are unsuitable for human drinking, where the water salinity ranges from 11028 to 43016 ppm.

Inorganic Pollutants:

The pollution of surface water samples is discussed through the measurements of trace elements, heavy metals and minor ions, including;, Al^{3+}, B^{3+} , Ba^{2+} ,Cd^{2+}, Co^{2+}, Cr^{3+}, Cu^{2+}, Fe^{3+}, Mn^{2+}, Mo^{2+}, Ni^{2+}, Pb^{2+}, Sr^{2+} , V^{2+} and Zn^{2+} as shown in Table (4).

Soluble heavy metals contents:

Based on the results of determined trace elements, heavy metals, minor ions and acceptable contaminant levels for drinking, it is clear that:

Table (4): Water quality guidelines for human drinking.

Chemical constituent or Parameter	Egyptian[1] maximum Permissible limit in mg/l	World[2]Health Organization guidelines mg/l
TDS	1200	1000
PH	6.5-8.5	6.5 – 9.2
Sodium	200	200
Sulfates	250 – 400	400
Calcium	200	--
Chloride	500	250
Magnesium If SO_4>250 mg/l If SO_4<250 mg/l	150	--
Aluminum	0.2	0.2
Manganese	0.05	0.1
Iron (total)	0.3-1	0.3
Lead	0.05	---
Nitrate as NitrogenRecommended	<50 for babies Less than three months	--
Acceptable	50-100 for older children and adults	--
Not recommended	>100	--

1- Egyptian standards for drinking and domestic uses (Higher committee for water, 1995)

2-Guidelines for drinking water quality,2nd ed. Vol.2 Health criteria and other supporting information, 1996 (pp.940-949) and Addendum to Vpl.2 1998 (pp.281-283) Geneva, World Health Organization.

1- The ions concentration of Al^{3+}, B^{3+} , Ba^{2+} ,Cd^{2+}, Co^{2+}, Cr^{3+}, Cu^{2+}, Fe^{3+}, Mn^{2+}, Mo^{2+}, Ni^{2+}, Pb^{2+}, Sr^{2+}, and Zn^{2+} in all the studied surface water samples (Nile, canals and mixed water) are below the acceptable levels of contamination, (0.2, 0. 5, 0.7, 0.005, 0.05, 0.05 ,0.05,1,0.5,0.01, 0.1, 0.05,7 and 5 mg/l, respectively).

2- Exceptional cases of the soluble heavy metals, are Al^{3+} in mixed Nile water, affected by Mediterranean sea , water sample No.22) and B^{3+} (all Nile water affected by Mediterranean sea), where Al^{3+} and B^{3+} concentration are more than recommended level for pollution (0.2 and 0.5 mg/l, respectively). The high concentration of soluble Al^{3+} in water sample No 22 is due to the deposition of most of the waste suspended materials or sanitary wastewater in irrigated canals, which increase the particle water interaction and subsequent release of such sparingly soluble metal. Consequently, the distribution of soluble heavy metal ions in the irrigation water was mainly affected by their occurrence in the liquid wastes discharged into them and the discharge of large amounts of drainage water containing impurities of soluble heavy metals from fertilizers and pesticides application together withindustrial wastes discharged into such drains.

The high concentrations of soluble B^{3+} in all mixedwater samples is either from the sea water contamination, (the sea water contains 5 mg/l as B^{3+}) or the pollution from domestic sewage water rich in boron content .

3- The soluble heavy metal V^{2+} concentration, ranges from <0.01 to 0.02 mg/l in all the examined surface water samples, however this heavy metal has no acceptable limit in the references.

Nitrate content:

Nitrogen fertilizers are the main source of nitratein the surface water. Nevertheless, all surface water samples have low content of nitrates (0.33-6.98 mg/l) ,i.e., less than that of the permissible limit for human drinking (45mg/l).

Phosphate content:

All the collected water samples have no content of phosphates,i.e., less than that of the recommended level (1 mg/l), “Chemistry of water and water pollution”, London, (13).

Evaluation of surface water quality for drinking of livestock and poultry:

Water is involved in every aspect of poultry metabolism. It plays an important roles in regulating body temperature, digesting food, and eliminating body wastes. Excessive salinity in livestock drinking water can upset the animal's balance and cause death.

By comparing the chemical analyses data of the surface water samples, with the permissible limits delineated by the classification of "Water quality criteria ",USA(Table 6), the majority of surface water samples (Nile and canals) are acceptable for livestock and poultry (excellent water), but all mixed water samples are unacceptable for livestock and poultry, where waters have TDS concentrations more than 10000 mg/l, i.e., risks with these highly saline waters are so great that they cannot be recommended for use under any conditions.

Evaluation of surface water for domestic and laundry uses:

The suitability of water samples collected from the surface water sources for the domestic uses was evaluated by comparing the values of different water quality parameters with the standards guideline values in (Table 7). However, the main factor for using the water in domestic uses is mainly restricted to water hardness. According to "Public water supplies of the 100 largest cities in the United States". Water can be classified based on its carbonate hardness as shown in (Table 7). Water should be ranging from soft to moderately hard to be used in domestic and laundry purposes.

Table (6): Guide to the use of surface waters for livestock and poultry.

Total soluble salts	Characters
(Less than 1000 mg/l) EC< 1.5 mmhos/cm	Relatively low level of salinity. Excellent for all classes of livestock and poultry.
(1000 – 3000 mg/l) EC = 1.5 – 5 mhos/cm	Very satisfactory for all classes of livestock and poultry. May cause temporary and mild diarrhea in livestock not accustomed to them; may cause watery droppings in poultry.
(3000 – 5000 mg/l) EC = 5 – 8 mmhos/cm	Satisfactory for livestock but may cause temporary diarrhea or be refused at first by animals not accustomed to them. Poor waters for poultry, often causing watery feces, increased mortality, and decreased growth, especially in turkeys.
(5000 – 7000 mg/l) EC = 8 – 11 mhos/cm	Can be used with reasonable safety for dairy and beef cattle, sheep, swine, and horses. Avoid use for pregnant or lactating animals. Not acceptable for poultry.
(7000 – 10,000 mg/l) EC =11–16 mmhos/cm	Unfit for poultry and probably for swine. Considerable risk in using for pregnant or lactating cows, horses or sheep, or for the young of these species. In general, use should be avoided although older ruminants, horses, poultry, and swine may subsist on them under certain conditions.
Over 10,000 mg/l EC >16 mmhos/cm	Risks with these highly saline waters are so great that they cannot be recommended for use under any conditions.

According to the values of carbonate hardness for surface water samples and referring to (Table 7), it is noted that all surface water samples are suitable for domestic and laundry uses after heating where the bicarbonate salts are precipitated. In details, the Nile water samples (73%), are moderately hard while (27%) of samples are hard. With regard to the canals water samples, 55% are moderately hard while (45%) of samples are hard. All mixed water samples are moderately hard.

Table (7): Classification of water for laundry usage according to its total hardness.

Classification	Carbonate hardness (mg/l as $CaCO_3$)
Soft	0-17
Slightly hard	17-60
Moderately hard	60 – 120
Hard	120 – 180
Very hard	More than 180

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