

Water chemistry analysis of Sawaiti (Barina) Swamp:

*A comparison of the concentration of different compounds in water from
swamp and adjacent water pan.*



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INTRODUCTION

The most important substance for humans in their surrounding material world is natural water. It is one of the most wonderful, not yet completely understood, combinations on the Earth. It possesses a complex of anomalous properties distinguishing it from all other substances, (e.g. anomalously high values for the temperature of melting, boiling, and evaporation, and heavy dissolving capacity).

Chemically pure water should be considered an extremely complex substance consisting of atoms of various isotopes of hydrogen and oxygen, which can form up to 18 isotope varieties of water. Under natural conditions, water corresponding to the known H₂O formula is not found in a chemically pure form.

The variety and complexity of natural water composition is defined not only by the occurrence of a large number of chemical elements in it, but also by the difference of forms and the values and presence of each of them. Almost all known chemical elements occur in natural water.

We can now be certain that the negative consequences of human economic activity upon the planet have a cumulative impact of enormous scope, on a scale of impact comparable with the natural processes happening on the planet. Practically all the natural components of the biosphere are exposed to direct or indirect anthropogenic impacts. The destabilizing effect of this on the most vulnerable part of the biosphere, the hydrosphere, has given rise to many problems, among which the problems of "pure water" has become the most urgent. This is due to the necessity to fulfill the human need for pure water in all manifestations of vital activity including everyday life, industry, and recreation. The urgency of the problem is associated with the poor quality of water and its shortage in some regions of the Earth (especially in the developing countries) in spite of sufficiency of fresh water on a global scale.

RESULTS

PARAMETERS	UNIT	RESULTS	WHO STANDARDS	KEBS(KS 459-1:2007) STANDARDS
pH	pH Scale	7.10	6.5-8.5	6.5-8.5
Colour	mgPt/l	150	Max 15	Max 15
Turbidity	N.T.U	25.5	Max 5	Max 5
Conductivity (25 ^o C)	μS/cm	353	Max 2500	-
Iron	mg/l	1.1	Max 0.3	Max 0.3
Manganese	mg/l	0.14	Max 0.1	Max 0.5
Calcium	mg/l	7.2	Max 100	Max 150
Magnesium	mg/l	2.43	Max 100	Max 100
Sodium	mg/l	12.82	Max 200	Max 200
Potassium	mg/l	94	Max 50	-
Total Hardness	mgCaCO ₃ /l	28	Max 500	Max 300
Total Alkalinity	mgCaCO ₃ /l	140	Max 500	-
Chloride	mg/l	12	Max 250	Max 250
Fluoride	mg/l	1.40	Max 1.5	Max 1.5
Nitrate	mgN/l	21.19	Max 10	-
Nitrite	mgN/l	<0.01	Max 0.1	Max 0.003
Sulphate	mg/l	<0.3	Max 450	Max 400
Free Carbon Dioxide	mg/l	38	-	-
Total Dissolved Solids	mg/l	218.9	Max 1500	Max 1000
Arsenic	μg/l	-	Max 10	Max 10
Others		-		

Fig.

1: The water analysis from Sawaiti swamp

PARAMETERS	UNIT	RESULTS	WHO STANDARDS	KEBS(KS 459-1:2007) STANDARDS
pH	pH Scale	7.01	6.5-8.5	6.5-8.5
Colour	mgPt/l	425	Max 15	Max 15
Turbidity	N.T.U	42.3	Max 5	Max 5
Conductivity (25 ^o C)	μS/cm	293	Max 2500	-
Iron	mg/l	2.8	Max 0.3	Max 0.3
Manganese	mg/l	0.80	Max 0.1	Max 0.5
Calcium	mg/l	6.4	Max 100	Max 150
Magnesium	mg/l	5.83	Max 100	Max 100
Sodium	mg/l	9.43	Max 200	Max 200
Potassium	mg/l	103	Max 50	-
Total Hardness	mgCaCO ₃ /l	40	Max 500	Max 300
Total Alkalinity	mgCaCO ₃ /l	72	Max 500	-
Chloride	mg/l	26	Max 250	Max 250
Fluoride	mg/l	1.26	Max 1.5	Max 1.5
Nitrate	mgN/l	5.75	Max 10	-
Nitrite	mgN/l	<0.01	Max 0.1	Max 0.003
Sulphate	mg/l	26	Max 450	Max 400
Free Carbon Dioxide	mg/l	52	-	-
Total Dissolved Solids	mg/l	181.7	Max 1500	Max 1000
Arsenic	μg/l	-	Max 10	Max 10
Others		-		

Fig 2: Water analysis from adjacent water pan

Comparison of some of the water composition

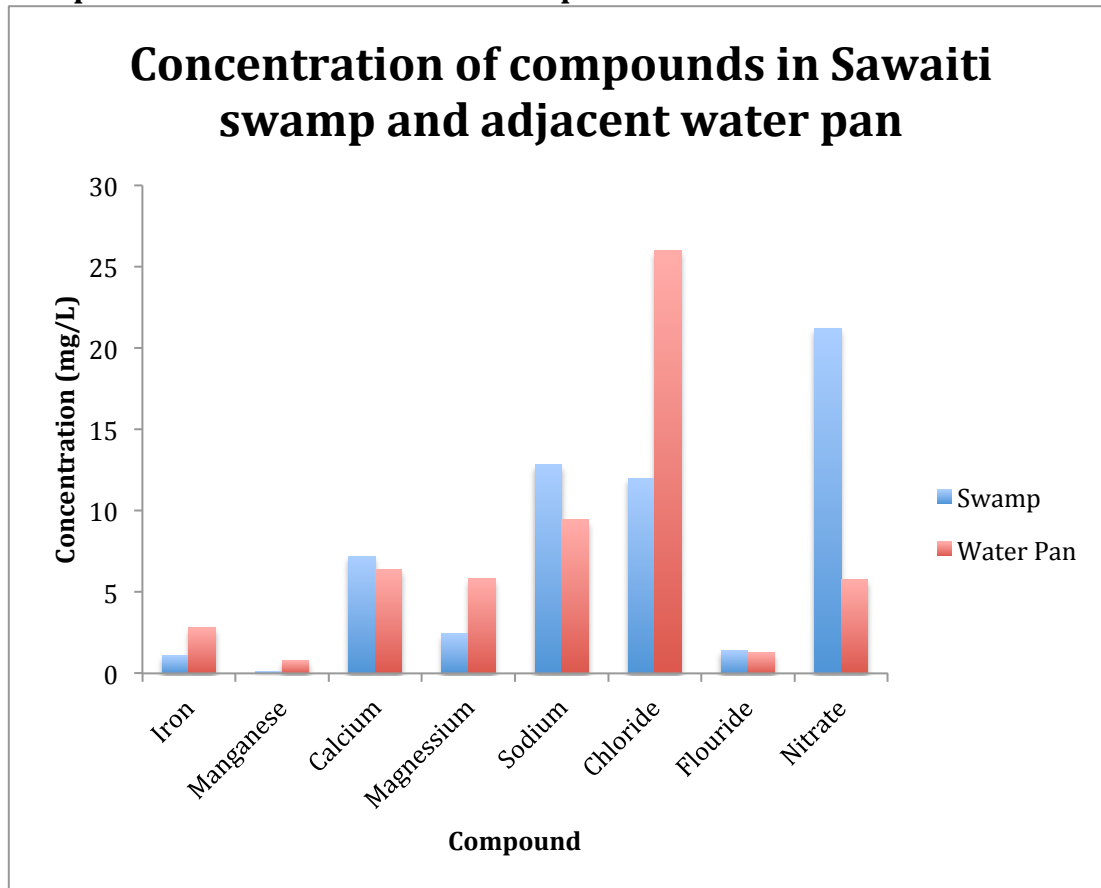


Fig 3: A graph showing the concentration of different compounds in the water pan and the Swamp

2. Chemical Composition of Natural Waters.

The chemical composition of natural water is classified under six headings:

1. Main ions
2. Dissolved gases
3. Biogeneous substances
4. Organic substances
5. Microelements
6. Pollutants

All components contained in natural waters give them certain properties—salinity, alkalinity, hardness, acidity, corrosivity, etc. Knowledge of water chemical

composition and its properties is necessary for the solution of scientific and applied problems concerned with water use for human domestic and other activity—water supply (drinking, hygiene, public, industrial, agricultural), fish-breeding, recreation, hydropower and hydraulic engineering, reclamation, exploration and exploitation of mineral deposits, etc.

Knowledge of the absolute magnitude of the concentrations of the components of water and their interactions permits specialists, for example:

1. To classify water according to chemical composition, dominant ions, total content of all substances;
2. To characterize water provision with nutrients (compounds of nitrogen, phosphorus, silicon and other) necessary for growth of hydrobionts;
3. To assess water pollution, and
4. To register cases of sudden rise in concentration of pollutants,
5. To reveal pollution sources, and
6. To make predictions about the future condition of water bodies.

The components of water chemical composition are the main characteristics of water quality that define its fitness for particular kinds of water use. Water quality assessment is performed according to certain parameters of water properties and composition, including concentrations of polluting harmful and toxic substances, which are categorized according to a harmfulness index. The standards of pollutant concentrations adopted in various countries are variously known as quality criteria, concentration standards, maximum allowable concentrations (MAC), maximum allowable levels (MAL), etc. Other measures of chemical substances dangerous for biota include classifications based on their type of effect—toxicity, carcinogenicity, mutagenity, etc. Different requirements specified for water quality are regulated by state normative documents, regulations on surface water protection from pollution, and standing standards. For this reason and also because of natural differences in chemical composition of water bodies in different regions, establishment of common, strict norms for water quality is extremely problematic.

Main ions

Mineral substances contained in natural waters in the dissolved state (in the form of ions, complex ions, undissociated compounds and colloids) are conventionally subdivided into macrocomponents and microcomponents. The macrocomponents comprise the so-called main ions that determine water chemical type and account for the bulk of natural water mineral content (up to 95% for fresh water and up to 99% for highly mineralized waters). The microcomponents comprise substances occurring only under certain conditions and in very small concentrations ($\mu\text{g l}^{-1}$ and $< 1 \text{ mg l}^{-1}$). An intermediate position is occupied by ions of hydrogen, compounds of nitrogen, phosphorus, and silicon dissolved in water. The concentration of all minerals is related to two main factors—the abundance of chemical elements in the Earth's crust and the solubility of their compounds. The main anions contained in natural water are Cl^- , SO_4^{2-} , HCO_3^- , and CO_3^{2-} and the main cations are Ca^{2+} , Na^+ , Mg^{2+} and K^+

Chloride ions (Cl^-) have a large migratory ability in connection with the very high solubility of chloride salts of sodium, magnesium and calcium. Their presence in water is naturally associated with the processes of leaching from minerals (e.g. gallite, sylvite, carnallite, bischofite), from rocks (e.g. nephelines), and from saline deposits. It is also present in atmospheric precipitation, and today it is particularly associated with industrial and municipal wastes. Chloride ions occur in all types of water in concentrations from parts of mg l^{-1} to hundreds of $\text{g}\cdot\text{kg}^{-1}$ (in brines).

Sulfate ions (SO_4^{2-}) are contained in all surface waters, and their content is limited by the presence of calcium ions together with which they form a slightly soluble CaSO_4 . The main source of sulfate in water is various sedimentary rocks which include gypsum and anhydrite. Water enrichment by sulfates takes place both by the process of oxidation of sulfide, which is abundant in the Earth's crust, and oxidation of hydrogen sulfide which is created during volcanic eruption and is present in atmospheric precipitation. The processes of decompositions and oxidation of substances of vegetable and organic origin containing sulfur, and also human

economic activity, have an effect on sulfur content in water bodies. The sulfate content of waters of rivers and freshwater lakes reaches several tens of $\text{mg}\cdot\text{l}^{-1}$.

Hydrocarbonate and carbonate ions (HCO_3^- and CO_3^{2-}) occur in natural waters in dynamic equilibrium with carbonic acid in certain quantitative proportions and form a carbonate system of chemical equilibrium connected with the pH of water. When the pH of a water system is 7 to 8.5 the predominant ion is hydrocarbonate. When pH is less than 5, the content of hydrocarbonate ions is close to zero. Carbonate ions dominate when $\text{pH} > 8$. The sources of HCO_3^- and CO_3^{2-} are various carbonate rocks (limestones, dolomites, magnesites), from which dissolution takes place with the participation of carbon dioxide. Hydrocarbonate ions always dominate in water with low mineralization, and often in waters with moderate mineralization. Accumulation of hydrocarbonate ions is limited by the presence of calcium ions, forming with HCO_3^- , a poorly dissolved salt. Usually in surface fresh waters HCO_3^- content does not exceed $250 \text{ mg}\cdot\text{l}^{-1}$ (with the exception of soda alkaline waters in which HCO_3^- and CO_3^{2-} content can reach grams and even dozens of grams per kilogram).

Ions of sodium (Na^+). The migratory ability of sodium as an element is rather high, as all its salts have high solubility. In waters with low mineralization Na^+ is third in concentration. With higher mineralization, the content of sodium rises, and in waters having mineralization of some $\text{g}\cdot\text{kg}^{-1}$ it becomes a dominant ion. A high proportion of the sodium ions is balanced by chlorine ions, forming a stable mobile combination that migrates with high velocity in a solution. The sources of Na^+ in waters are deposits of various salts (rock-salt), weathering products of limestone rocks, and its displacement from the absorbed complex of rocks and soils by calcium and magnesium.

Ions of Potassium (K^+). Potassium, in terms of the magnitude of its content in the Earth's crust and the solubility of its compounds, is very similar to sodium. However, it occurs in lower concentrations in surface waters as it has weak migratory ability. This is due to its active participation in biological processes, e.g. absorption by living

plants and micro-organisms. Ions calcium. (Ca^{2+}). The basic sources of calcium are carbonate rocks (limestone's, dolomites) that are dissolved by carbonic acid contained in water. When the availability of carbon dioxide (with which it in a balance), is low, however, the reaction begins to proceed in a reverse direction, accompanied by precipitation of CaCO_3 . Another source of Ca^{2+} in natural waters is gypsum, is common in sedimentary rocks. Calcium ions dominate in the cation composition of low-mineralized waters.

Ions of magnesium (Mg^{2+}). Magnesium is less abundant than calcium in the Earth's crust. It enters surface water as a result of the processes of chemical weathering and dissolution of dolomites, marls, and other rocks. Magnesium ions occur in all natural waters, but very seldom dominate. Its concentration in river waters ranges from one to tens of $\text{mg}\cdot\text{l}^{-1}$. The weaker biological activity of magnesium, as compared with calcium, and also the higher solubility of magnesium sulfate and hydrocarbonate as compared the equivalent compounds of calcium, favor increase of Mg^{2+} concentration in water. With higher water mineralization, the ratio between calcium and magnesium begins to change towards predominance of the latter.

Conclusion

This analysis presents a clear description of the compounds present in the swamp and the water used for domestic purposes. It is noted that there is a much higher concentration of nitrates in the swamp, which is a clear indication of the buffer capacity and the filtration function of the swamp. This filtered water leads to the less nitrate concentration in the water pan that is used by the community.

It is however important to note that the results are partially inconclusive as its required that a second sampling is done in a wet season. This sampling was done during the dry season (July) and therefore some concentrations might be lower or higher.