Factors Controlling the Distribution of the Major Metals in Lake Nasser Water

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Abstract: The present study was carried out to deal with the factors affecting the distribution of major cations namely, sodium, potassium, calcium and magnesium in the main channel of Lake Nasser during the year 2005. Available data shown that the concentrations of Na, K, Ca and Mg in water are naturally variable from season to another according to change in physicochemical parameters as temperature, dissolved oxygen (DO), pH and suspended solids coming with water flood in southern part of the lake Nasser. There is a wide variation in the concentrations of major metals between surface and bottom layers during summer season, especially in northern part of the lake. During winter, the difference in metal concentrations between surface and bottom layers was of low value. During winter, sodium adsorption ratio (SAR) values were relatively higher in the northern than in the southern part of Lake Nasser. The phenomena are reversed in the summer. In general, the low SAR values estimated in the present study indicate that the Nasser Lake water is very good quality for drinking, irrigation and fisheries. The obtained data, shows that, the Basic Ratio (BR) values below 1.0 in all sites along Lake Nasser indicates oligotrophy whereas the water quality in the Lake during summer is suitable for blue green algae and diatoms as compared with the low value recorded during winter, it will has below 0.3 indicate dystrophy. It could be concluded that, the concentrations of Na, K, Ca and Mg in different seasons and regions in Lake Nasser water lie within the permissible range and it is of good quality for drinking and fish culture.

Key words: Major metals • Lake Nasser water • Sodium adsorption ratio • Basic ratio

INTRODUCTION

Major metals concentrations (Ca²⁺, Mg²⁺, Na⁺, K⁺) are naturally variable from season to other in water according to changes in environment conditions such as temperature, turbidity, dissolved solids, pH, dissolved oxygen and redox potential condition [1] as well as increases in the decay organic matter [2] which cause the release of these metals to overlying water. Also, the adsorption of metals on the surface of fine suspended particles plays an important role on the distribution of metals in the aquatic environment [3]. It was reported that the concentrations of major metals in Lake Nasser are controlled by the changes in the physicochemical conditions, deposition and dissolution between water and sediment [4-8]. The major anions and cations in northern area of Nasser Lake were studied by Sayyah et al. [9]. The study included measuring the concentrations of sodium, potassium, calcium, magnesium in surface and bottom water layers in different seasons with emphasis on the effect of flood water on the distribution of major cations in fresh water [10].

The present work was carried out to deal with the dynamic distribution of major cations, namely sodium, potassium, calcium and magnesium to overlying water under oxic and anoxic conditions of Lake Nasser water. The obtained data as Basic Ratio (BR) and Sodium Adsorption Ratio (SAR) could be used to assess the water quality in Lake Nasser for utilization like drinking, irrigation and other purposes.

MATERIALS AND METHODS

Water samples were collected from subsurface and near bottom of Lake Nasser by Van Dorn bottle and kept in polyethylene bottle. The sampling program was carried out during winter and summer form 10 stations of main channel of Lake (Fig. 1) during the, 2005.

Table 1 illustrate the sampling stations and its distance south High Dam (Km) and total depths (m) for each site.

Method of Analysis: The physical and chemical parameters were analyzed according APHA [11] to
Table 1: Some data about sampled stations

<table>
<thead>
<tr>
<th>Sites No.</th>
<th>Location</th>
<th>Average Depths</th>
<th>Distance Sou. H.D</th>
<th>Sites No.</th>
<th>Location</th>
<th>Aver. Depths</th>
<th>Dist. Sou.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ashken</td>
<td>37</td>
<td>320</td>
<td>6</td>
<td>Wadi Elarab</td>
<td>88</td>
<td>171</td>
</tr>
<tr>
<td>2</td>
<td>Adruran</td>
<td>44</td>
<td>340</td>
<td>7</td>
<td>El-Medq</td>
<td>77</td>
<td>127</td>
</tr>
<tr>
<td>3</td>
<td>Abu Simbel</td>
<td>53</td>
<td>230</td>
<td>8</td>
<td>Gerf Hussein</td>
<td>51</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>Maasat</td>
<td>58</td>
<td>235</td>
<td>9</td>
<td>El-Alaq</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>5</td>
<td>Abatium</td>
<td>55</td>
<td>228</td>
<td>10</td>
<td>Kalthaha</td>
<td>96</td>
<td>50</td>
</tr>
</tbody>
</table>

Fig. 1: Map of Lake Nasser showing stations of study

determine regional variations in different parameters. Calcium and magnesium were determined by titration with EDTA 0.01 M, titrimetric method using Eriochrome black T as indicator and buffer pH 10 (NH₄ Cl) and (NH₄OH), while calcium only was determined by titration with EDTA, 0.01M using MuriXide as indicator and pH 11 (NaOH or KOH,1N) in presence KCN. Sodium and Potassium cations were measured directly using flam photometer (Model, JENWAY PFP7). Their concentrations were deduced from calibration curves drawing from series of standard solutions.

Statistical Analysis: Interpreting results from a large quantities of data involving many variables, could be used a computer (Minitab program). Correlation coefficient matrix were estimated between all pairs of measured variables to understanding the dynamic and mechanisms of precipitation and dissolution of major metals under investigation. While Sodium adsorption ratio (SAR) can be calculated as following equation [12].

\[ \text{SAR} = \frac{[\text{Na}^+] + [\text{Ca}^+] + [\text{Mg}^+]}{2} \]

Where Na, Ca, Mg are the miliequivalent

Basic ratio (BR) value can be estimated according to Badr, et al. [3] as the following equation:

\[ \text{BR} = \frac{M_1}{M_2} = \frac{[\text{Na}]}{[\text{K}]} + [\text{Ca}] + [\text{Mg}] \]

Where M₁ is (Na+K) & M₂ is (Ca+Mg) per miliequivalent.
RESULTS

The concentrations of Na, K, Ca and Mg are variable according to change in physicochemical parameters. During summer show a wide variation in metal concentrations between surface and bottom layer mainly due to development thermocline and formation strong stratification in water column especially in northern part of the Lake. During winter, the variation in concentrations of these metals between surface and bottom layer was low value, probably due to the mixing between different water masses (vertically homothermal). The high Na, K and Mg contents were measured in summer due to decomposition of large amount of bacteria and organic matter resulted to high water temperature and low oxygen content. While, the decrease in metal levels measured during winter principally related to assimilation by phytoplankton and aquatic plants. As well as the high Na, K and Mg values were recorded during summer in southern sites of the Lake related to the increasing the solubility of some suspended particles which coming with flood. Whereas flood water originating from Ethiopian highland which is known by its high turbidity.

The correlation coefficient matrix between major metals and different parameter were estimated in (Table 2) to throw light on the dynamic distribution of these metals in the Lake water.

Sodium (Na): The distribution of sodium concentrations in Lake water is graphically represented in (Fig. 2). The absolute maximum value 19.2 mg l\(^{-1}\) was recorded at site 3 during summer while the minimum value 8.2 mg l\(^{-1}\) detected at site 1 during winter. Sodium contents were higher in the northern than in the southern areas of Nasser Lake during winter, while the phenomena is reversed during summer whereas the Na was higher in the southern than the northern areas.

Potassium: The absolute maximum value was 7.0 mg l\(^{-1}\) measured at site 3 during summer as compared with the minimum value 1.9 recorded at site 2 during winter (Fig. 3).

Calcium: The distribution of calcium contents in Lake Nasser were represented graphically in, Fig. 4. It varied between 24.8 -30.8 mg l\(^{-1}\) during winter. The lowest Ca\(^{2+}\) value recorded in southern area at site 1 as compared with the highest value found in median area of Lake at site 7.

### Table 2: Correlation coefficient matrix between major metals and different parameters, 2005

<table>
<thead>
<tr>
<th></th>
<th>Na</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp.</td>
<td>0.675</td>
<td>0.721</td>
<td>-0.835</td>
<td>0.826</td>
</tr>
<tr>
<td>pH</td>
<td>0.581</td>
<td>0.588</td>
<td>0.573</td>
<td>0.510</td>
</tr>
<tr>
<td>DO</td>
<td>-0.537</td>
<td>-0.667</td>
<td>0.771</td>
<td>-0.675</td>
</tr>
<tr>
<td>EC</td>
<td>0.632</td>
<td>0.477</td>
<td>0.385</td>
<td>0.501</td>
</tr>
<tr>
<td>NTU</td>
<td>0.095</td>
<td>0.254</td>
<td>-0.315</td>
<td>0.136</td>
</tr>
<tr>
<td>TDS</td>
<td>0.297</td>
<td>0.158</td>
<td>0.272</td>
<td>0.352</td>
</tr>
<tr>
<td>PO(_4)</td>
<td>0.513</td>
<td>0.504</td>
<td>-0.654</td>
<td>0.353</td>
</tr>
<tr>
<td>NH(_3)</td>
<td>0.014</td>
<td>0.077</td>
<td>0.691</td>
<td>-0.059</td>
</tr>
<tr>
<td>NO(_3)</td>
<td>0.269</td>
<td>0.179</td>
<td>-0.087</td>
<td>0.186</td>
</tr>
<tr>
<td>NO(_2)</td>
<td>0.507</td>
<td>0.708</td>
<td>-0.608</td>
<td>0.538</td>
</tr>
<tr>
<td>SO(_4)</td>
<td>-0.687</td>
<td>-0.598</td>
<td>0.457</td>
<td>-0.779</td>
</tr>
<tr>
<td>Cl</td>
<td>0.047</td>
<td>-0.309</td>
<td>0.581</td>
<td>-0.146</td>
</tr>
<tr>
<td>CO(_3)</td>
<td>0.369</td>
<td>0.198</td>
<td>0.104</td>
<td>0.061</td>
</tr>
<tr>
<td>HCO(_3)</td>
<td>0.596</td>
<td>0.510</td>
<td>0.518</td>
<td>0.354</td>
</tr>
<tr>
<td>Mg</td>
<td>0.803</td>
<td>0.761</td>
<td>-0.579</td>
<td>0.252</td>
</tr>
<tr>
<td>Ca</td>
<td>-0.524</td>
<td>-0.603</td>
<td>0.779</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: Major metals in surface water of Lake Nasser (meq), Sodium Adsorption Ratio (SAR) and Basic Ratio (BR) during summer

<table>
<thead>
<tr>
<th></th>
<th>Na</th>
<th>K</th>
<th>Na+K</th>
<th>Ca</th>
<th>Mg</th>
<th>Ca+Mg</th>
<th>SAR</th>
<th>BR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Areno</td>
<td>0.780</td>
<td>0.138</td>
<td>0.918</td>
<td>0.88</td>
<td>0.712</td>
<td>1.592</td>
<td>0.890</td>
<td>0.577</td>
</tr>
<tr>
<td>Adindan</td>
<td>0.804</td>
<td>0.146</td>
<td>0.950</td>
<td>0.86</td>
<td>0.817</td>
<td>1.677</td>
<td>0.878</td>
<td>0.566</td>
</tr>
<tr>
<td>Abo-simbel</td>
<td>0.826</td>
<td>0.179</td>
<td>1.005</td>
<td>0.84</td>
<td>0.835</td>
<td>1.675</td>
<td>0.914</td>
<td>0.600</td>
</tr>
<tr>
<td>Masem</td>
<td>0.783</td>
<td>0.131</td>
<td>0.914</td>
<td>0.86</td>
<td>0.712</td>
<td>1.570</td>
<td>0.886</td>
<td>0.581</td>
</tr>
<tr>
<td>Abrium</td>
<td>0.740</td>
<td>0.090</td>
<td>0.830</td>
<td>0.80</td>
<td>0.680</td>
<td>1.480</td>
<td>0.860</td>
<td>0.561</td>
</tr>
<tr>
<td>Wadi-El-arab</td>
<td>0.739</td>
<td>0.115</td>
<td>0.854</td>
<td>0.98</td>
<td>0.680</td>
<td>1.660</td>
<td>0.840</td>
<td>0.510</td>
</tr>
<tr>
<td>Garf-Hussien</td>
<td>0.774</td>
<td>0.126</td>
<td>0.902</td>
<td>0.90</td>
<td>0.817</td>
<td>1.717</td>
<td>0.836</td>
<td>0.525</td>
</tr>
<tr>
<td>El-madiq</td>
<td>0.717</td>
<td>0.087</td>
<td>0.804</td>
<td>0.91</td>
<td>0.712</td>
<td>1.622</td>
<td>0.797</td>
<td>0.498</td>
</tr>
<tr>
<td>El-allaq</td>
<td>0.695</td>
<td>0.141</td>
<td>0.836</td>
<td>0.88</td>
<td>0.600</td>
<td>1.480</td>
<td>0.808</td>
<td>0.565</td>
</tr>
<tr>
<td>Kalabaha</td>
<td>0.674</td>
<td>0.090</td>
<td>0.764</td>
<td>1.26</td>
<td>0.880</td>
<td>2.140</td>
<td>0.654</td>
<td>0.357</td>
</tr>
</tbody>
</table>
During summer, the Ca\(^{2+}\) levels ranged between 16.8 - 25.2 mg l\(^{-1}\), the lowest value was recorded at site 3 while the highest value was detected at site 10 in northern site of Lake Nasser.

**Magnesium:** The concentration of magnesium varied between 6.8-8.6 and 7.2-10.56 mg l\(^{-1}\) during winter and summer respectively (Fig. 5), the high value was measured during summer while the low value was recorded during winter season. During summer Mg decreased from south to north of Nasser Lake. In contrast the phenomenon is reversed in winter whereas Mg increased from south to north direction. On the other hand, Mg was higher in bottom than in the surface layers during summer.

**Sodium Adsorption Ratio (SAR):** Sodium adsorption ratio (SAR) values were recorded in Table 3 - 6, it varied from 0.370 to 0.914 during the period of study. The minimum value was 0.370 estimated in bottom water layer in southernmost area at site 1 during winter. While the maximum SAR value was 0.914 recorded at site 3 during summer (Table 3). During winter, SAR values were higher in northern than in southern sites, the phenomena was reversed in summer whereas the SAR values were higher in the southern than in northern areas. On the other hand, the average SAR value in the surface water was higher than the value calculated in bottom water in different seasons along of the Lake Nasser.
Fig. 2: Concentrations of sodium mg l\(^{-1}\) in Lake Nasser water during the period, 2005

Fig. 3: Concentrations of potassium mg l\(^{-1}\) in Lake Nasser water, 2005

Fig. 4: Concentrations of calcium mg l\(^{-1}\) in Lake Nasser water during the period, 2005

Fig. 5: Concentrations of magnesium mg l\(^{-1}\) in Lake Nasser water during, 2005
Basic Ratio (BR): The seasonal and regional variations of BR in Lake water in the surface and bottom layers were estimated in Table 3-6. It ranged between 0.22 and 0.60 during the period of study; the diatoms development in water exhibiting a low basic ratio M£ / M£ = 1.5 in fresh water environment. The highest value was 0.60 calculated at site 3 during summer as compared with the lowest value recorded at site 1 in bottom layer during winter. On the other side, BR value in the surface water layer was higher than those calculated in bottom layer during the period of study. Also, BR values in summer were higher than those estimated in winter.

DISCUSSION

The concentrations of Na, K, Ca and Mg were analyzed to throw light the factors affecting the precipitation and dissolution of these metals in Lake Nasser water under aerobic and anaerobic conditions. Also, Sodium Adsorption Ratio (SAR) and Basic Ratio (BR) were estimated could be used to assess the water quality in Lake Nasser for utilization like drinking, irrigation phytoplankton assemblage and fish culture.

The increase in sodium concentration recorded during summer proves that the solubility of sodium salts increases with increasing water temperature [13]. This conclusion was confirmed by positively significant correlation between two parameters (0.675), whereas Na⁺ release from sediment to water during hot season as the following equation:

\[4Na_2SiO_3 + 2Ca^{++} + 2H_2SiO_3 + 3Al_2SiO_3(OH)_6 \rightarrow 2Na^+ + 2Ca^{++} + 2H_2SiO_3 + 3Al_2SiO_3(OH)_6\]

The positive correlation coefficient was estimated between Na and pH value (0.581) resulted from hydrolysis of sodium salts to produce Na OH (strong base) as follows:-

\[Na_2CO_3 + 2 H_2O \rightarrow 2 NaOH + H_2CO_3\]

The positive significant relationship between Na and DO (-0.532) may be related to consumption of DO on the oxidation organic matter contain sodium ions. Also, the negative significant relationship between sodium and calcium (-0.524) may be due to replacement reaction or dissociation of sodium calcium hexaphosphate as follows:

\[Na_4Ca[(PO_4)_3 + 2CaCO_3 - 3Ca(PO_4)_3 \downarrow + 2Na_2CO_3\downarrow\]

In contrast, the positive correlation coefficient between Na and nitrate (0.507), proved that sodium is present in Lake Water as NaNO3 form. While the reversible relationship between Na and silicate may be due to exchangeable reaction between soluble silicate and other metal salt to produce insoluble silicate salts, discharged from water to bottom sediment as follows:-

\[M_2SiO_3 + Me Cl_2 \rightarrow Me SiO_3 \downarrow + 2 Na Cl\]

Where M is Na, K or H & while Me is, Fe, Cu, Zn,......

\[Na_2SiO_3 + 2Al Cl_3 \rightarrow Al_2(SiO_3)_3 \downarrow + 2 Na Cl\]

Sodium is positively correlated with carbonate (0.596) indicating that sodium in Lake found as Na2CO3 form. Also, the strong positive significant relationship between Na and K (0.779) indicated that the two metals were same trend during the period of study. The low potassium level was detected in winter due to its adsorption on to clay mineral [11]. While the high potassium measured in summer ascribed to the increase solubility of potassium salts with rise water temperature (0.721), as well as the organic matter which contain potassium was decay.

The positive correlation coefficient between K and soluble phosphate indicates that potassium in Lake water formed as potassium dihydrogen orthophosphate (KH2PO4). Also potassium is positively significant with pH value (0.588) ascribed to hydrolysis of potassium salts to produce KOH. This process leads to increase in pH value of water, as follows:

\[K_2CO_3 + 2 H_2O \rightarrow 2 K OH + H_2CO_3\]

The positive relationship between carbonate and potassium prove that potassium is formed as K2CO3 in Lake water, as well as the strong positive correlation coefficient estimated between K and NO3 indicate that potassium present as KNO3 in water during the period of study. Potassium has a negatively correlated with silicate (-0.598). This is may be related to exchangeable reaction [14] as the following equations:

\[K_2SiO_3 + Me Cl_2 \rightarrow Me SiO_3 \downarrow + 2 K Cl\]

Where M is Fe, Cu, Mg,......Alc

\[3K_2SiO_3 + 2 Al Cl_3 \rightarrow Al_2(SiO_3)_3 \downarrow + 6 K Cl\]
The high Ca\(^{2+}\) measured in winter was attributed to the high carbonate and bicarbonate contents [15]. Also, the low Ca\(^{2+}\) in Lake water was mainly attributed to diminish of carbonic acid consequently the calcium carbonate crystallized out and precipitates to the sediment or assimilation by plankton and fish [8]. In contrast, the calcium value was high in bottom water than its value in the surface layer during the hot season probably due to decay of organic matter and organisms present in bottom sediment which containing considerable amount of calcium[16]. Calcium has a strong negative significant relationship with temperature (-0.835) indicate that Ca\(^{2+}\) increases in cold season. While calcium was positively correlated with pH (0.537) probably due to the increase of solubility of HCO\(_3^-\) and CO\(_3^{2-}\) leads to increase in pH value. Also, when pH value increased most of CaCO\(_3\) dissolved to formation of carbonic acid and OH\(^{-}\) as follows:

\[
CaCO_3 + H^+ \rightarrow Ca^{2+} + HCO_3^-
\]

\[
HCO_3^- + H_2O \rightarrow OH^- + H_2CO_3
\]

The positive correlation relationship was estimated between calcium and sulphate (0.581) proves that calcium is present in soluble form as CaSO\(_4\) in Lake Water. The negative correlations coefficient estimated between Ca\(^{2+}\) and Na\(^{+}\) (-0.524) and K\(^{+}\) (-0.603) were mainly related to ion exchange reaction as following equations:

\[
CaCO_3 + 2Na^+ \rightarrow Ca^{2+} + Na_2CO_3
\]

\[
CaCO_3 + 2K^- \rightarrow Ca^{2+} + K_2CO_3
\]

\[
CaSO_4 + 2Na^+ \rightarrow Ca^{2+} + Na_2SO_4
\]

\[
CaSO_4 + 2K^- \rightarrow Ca^{2+} + K_2SO_4
\]

\[
CaCl_2 + 2Na^+ \rightarrow Ca^{2+} + 2NaCl
\]

Calcium is negatively correlated with nitrate (-0.608) may be due to the following reaction:

\[
Ca(NO_3)_2 + SiO_2^{2+} \rightarrow Ca SiO_3 l + 2NO_3^{-}
\]

As well as, Ca\(^{2+}\) is negatively significantly correlated with soluble phosphate may be due to dissociation of sodium calcium hexaphosphate [14], as follows:

\[
Na_4Ca(PO_4)_6 + 2NaCl \rightarrow (NaPO_4)_l + Ca^{2+} + 2Cl^{-}
\]

As well as, calcium has a negatively correlated with magnesium (-0.579) may be related to dissociation of calcium magnesium carbonate [7], as the following equation:

\[
Ca Mg (CO_3)_2 + 2Na^+ \rightarrow Mg^{2+} l + CaCO_3 l + Na_2CO_3
\]

The higher magnesium level in bottom layer than those recorded in the surface layer during summer may be due to uptake by phytoplankton. As well as, the high Mg in water during summer which is probably due to dissociation of magnesium carbonate trihydrate at high temperature and low oxygen content [15], as following equation:

\[
Mg CO_3 \cdot 3H_2O \rightarrow Mg^{2+} + CO_3^{2-} + 3H_2O
\]

In addition, the organic matter and aquatic macrophytes are decay at high temperature [17] and Mg\(^{2+}\) release to surrounded water, this conclusion from the strong positive correlation coefficient between Mg and temperature (0.826). As well as the positive correlation coefficient between Mg and pH value (0.510), related to the increase solubility of Mg (HCO\(_3^-\)) and Mg CO\(_3\) in water leads to increase in pH value. While the negative significant calculated between Mg and Ca (-0.579) due to dissociation of calcium magnesium carbonate which found in sediment as follows:

\[
Ca Mg (CO_3)_2 + Mg^{2+} l + CaCO_3 l + CO_3^{2-}
\]

The high positively significant between Mg with both Na (0.803) and K (0.701) was probably due to reaction between carbonic acid and clay mineral present in sediment as follows:

\[
4Na_2O \cdot MgO \cdot Al_2O_3 \cdot SiO_2 + 6H_2CO_3 + 11H_2O \rightarrow 2Na^+ l + 2Mg^{2+} l + 2H_4SiO_4 + 3Al_2Si_2O_7(OH)_2
\]

\[
4K_2O \cdot MgO \cdot Al_2O_3 \cdot SiO_2 + 6H_2CO_3 + 11H_2O \rightarrow 2K^+ l + 2Mg^{2+} l + 2H_4SiO_4 + 3Al_2Si_2O_7(OH)_2
\]

The strong negatively significant relationship between Mg and soluble silicate (-0.779) may due to replacement reaction between MgSiO\(_4\) and Aluminium chloride to produce soluble magnesium salt Aluminium silicate as follows:-
According to National River Water Quality standards [18], can be observed that the concentrations of Na, K, Ca and Mg in different seasons and regions in Lake Nasser lie within the permissible range. Major metals as Ca, Mg, Na, K concentrations in Lake Nasser water changed from season to another according to climate, environment conditions [5,19] and flood season. Sodium adsorption ratio (SAR) calculation helps in estimation of severity of Na concentration. The enrichment and distribution of SAR in water depends on combination of physicochemical and biological factors [3, 12]. The lowest SAR value was recorded during winter, mainly due to the adsorption of sodium ions on the fine silt or clay fractions and discharged to bottom sediment, where this area exists with high turbidity. While the highest SAR value was recorded at site 3 during summer. This is ascribed to the low Ca and high Na in water during this station. In general, the low estimated SAR values indicated that the Nasser Lake water is very soft and good quality for drinking and other organisms. The higher Basic Ratio (BR) in summer than those found in winter was mainly related the increase of solubility of Na and K with rise water temperature while CaCO3 & CaSO4 are crystallized out and discharged from water to bottom sediment in hot season. As well as, the high water temperature cause increasing rate of ion exchangeable as follows:

$$Na_2SO_4 + CaCl_2 \rightarrow CaSO_4 + 2NaCl$$

Basic ratio (BR) for a long time has been considered useful to predict the phytoplankton assemblage in the water mass. Badr et al. [3] reported that the BR from 0.1 to 0.3 indicate dystrophy. The values below 1.0 indicate oligotrophy. The value above 1.0 indicated eutrophy and is suitable for desmids. From the obtained data, the average BR in southern area of Lake Nasser from site 1 to site 5 were below 0.3 during winter indicate dystrophic while the values in northern area, from site 6 to site 10 were oligotrophic and favourable for blue green algae and diatoms. In summer, the BR ratio varied 0.354 - 0.60 and 0.350 -0.440 in the surface and bottom water layers respectively. Basic Ratio (BR) values below 1.0 in all sites along Lake Nasser. This indicates that the water quality in the Lake during summer is suitable for blue green algae and diatoms more than winter season.

In conclusion, the concentrations of Na, K, Ca and Mg in water are depend on the change in physicochemical parameters and water flood in southern part of Lake Nasser. The enrichment and distribution of sodium adsorption ratio (SAR) in Lake Nasser water depends on combination of environmental conditions and biological parameters. In general, Lake Nasser water has low SAR values indicate that the Nasser Lake water is very soft and good quality for drinking and irrigation. Also, the basic ratio (BR) below 1.0 in all sites along Lake Nasser indicates that the water quality in the Lake is suitable for blue green algae and diatoms.

REFERENCES


