International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 04, April-2021

Water Salt Toxicity Assessment for the Nile River - Damietta Branch and Evaluating its Suitability for Irrigation Process

Amany F. Hasaballah, T. A. Hegazy, M. S. Ibrahim, and Doaa A. El-Emam
Environmental Science Department,
Faculty of Science, Damietta University,
New Damietta City, Egypt

Abstract:- **This study was conducted to monitor surface water salts along the Damietta Branch-Nile River for a yearlong period to evaluate its quality for irrigation. Damietta Branch was divided into twelve stations along through it where water samples were collected and some physicochemical parameters were analyzed. Results obtained confirmed that the SAR value of water along the branch ranged from 3.93 to 60.28 eq/l. According to SAR calculations and characterizations, it is obtained that Damietta branch water is classified as medium (good water quality), which is suitable for coarse textured or organic soil with good permeability and relatively unsuitable in fine textured soils. Nevertheless, its quality varied between several classes (low, medium, high and very high) at different stations separately along the branch. The PAR value of water along the branch ranged from 1.72 to 25.55 eq/l. Thus, Damietta branch water is classified as having low to medium risk of soil dispersion (low to medium water quality) but real risk values are for waters low in EC, typically < 65mS/m). However, different stations along the branch varied between several classes (low, medium, high and very high). The ESP value of water along the Damietta Branch ranged from 12.96 to 68.68 and with a mean value of 43.04±20.2 along the branch. Chloride, Sodium, Calcium, and potassium concentration values in water along Damietta Branch were distributed in a regular manner as it increased from upstream to downstream along Damietta branch except for one or two stations.: $Na^+ > K^+ > Cl^- > Ca^{++} > Mg^{++}$**

Keywords:- Salts toxicity; Damietta Branch; Nile River; Irrigation; Water Monitoring

I. INTRODUCTION

Nowadays, scarcity and pollution of fresh surface water is considered one of the most critical environmental issues. Irrigation accounts for approximately 70 percent of global water withdrawal and 87 percent of consumptive water usage. Irrigated farm land accounts for less than a quarter of all cropped land, which only yields about 40–45% of global food production. Thus, it is widely anticipated that irrigation will need to be significantly expanded in the future in order to meet future demand, **[1]**. However, it is unknown if enough water will be sufficient to complete the requisite extension. As it is very likely that water demands in the domestic and industrial sectors are expected to rise in the future and even regions that do not currently face water shortages are thought to be limited in their irrigation and agricultural production, and hence food security will take place, due to a lack of water, **[2]**.

Thus, registration system and good measurement for water quality, usage and disposal in general and usage of water for irrigation in particular should be monitored and recorded in every region for the prediction of problems which may occur and work on the development of agriculture and the food sector, **[3]**. This system of monitoring will also help in the assessment of water and food issues on a continental and global scale.

The composition of salts in water varies according to the source and properties of the constituent chemical compounds. These salts include substances such as gypsum (calcium sulphate, $CaSO_4.2H_2O$), table salt (sodium chloride NaCl) and baking soda (sodium bicarbonate $NaHCO_3$). When dissolved in water, salts separate into ions; e.g. sodium chloride breaks down into sodium and chloride ions, **[4]**, **[5]**.

Chloride is a common ion in irrigation waters. Although it is essential to plants in very low amounts, it can cause toxicity to sensitive crops at high concentrations. In addition, chlorine alone as Cl_2 is highly toxic and it is often used as a disinfectant. In combination with a metal such as sodium it becomes essential for life. Small amounts of chlorides are required for normal cell functions in plant and animal life, **[6]**. Furthermore, Na is an important cation which in excess deteriorates the soil structure and reduces crop yield. When the concentration of Na^+ is high in irrigation water, Na^+ tends to be absorbed by clay particles displacing Mg^{2+} and Ca^{2+} ions. This exchange process of Na^+ in water for Ca^{2+} and Mg^{2+} in soil reduces the permeability and eventually results in soil with poor internal drainage. This percentage should not exceed 60, (Table 4), **[7]**.

The sodium adsorption ratio (SAR), the potassium adsorption ratio (PAR) and Exchangeable sodium percentage (ESP) are used to assess irrigation water and provide a useful indicator of its potential damaging effects on soil physical properties, such as soil structure and its permeability, [8]. SAR is used to assess the relative concentrations of sodium, calcium, and magnesium ions in soil and. The permissible value of the SAR is a function of salinity. High SAR leads to a breakdown in the physical structure of the soil. Sodium is adsorbed and becomes attached to soil particles. The highest SAR values were associated with irrigation contaminated and diluted by sea water, **[9].** The potassium adsorption ratio (PAR) describes the ratio of K^+ to Ca^+ and $Mg^{2+.}$ High PAR values in water

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 04, April-2021

with low EC values can affect soil properties by making the soil more dispersible. While ESP is the percentage of the capacity that sodium takes up, it is known as the exchangeable sodium percentage. The degree of sodium absorption by clay particles is determined by the concentration of sodium in the water as well as the concentrations of calcium and magnesium ions, **[10]**. This reaction is called cation exchange and it is a reversible process. The capacity of soil to adsorb and exchange cations is limited. Soils with ESP > 15 are seriously affected by adsorbed sodium. The use of water with a high SAR value and low to moderate salinity may be hazardous and reduce the soil infiltration rate. The SAR of irrigation water indicates the approximate ESP of a soil with water, **[11], [12].**

This study was conducted in order to assess the irrigation water quality of the Nile River-Damietta Branch depending on the evaluation of its salt concentration at twelve locations over one year using mathematical method (SAR, PAR and ESP).

II. MATERIAL AND METHOD

A. *Water Sampling*

Water samples were collected seasonally for a yearlong period, from the River Nile-Damietta Branch, Egypt. Twelve sampling stations were selected along the Damietta Branch**,** from its beginning at Cairo governorate to its estuaries in the Mediterranean Sea, (Fig.1). The global positioning system (GPS) was used for recording these geographical locations, (Table 1). Water samples were collected in HDPE Jerry Cans that were routinely treated with 0.5 N HCl and rinsed before usage with de-ionized water. It was then rinsed with water sample before actual sampling. Physicochemical parameters such as pH, TDS, EC, salinity, sodium, calcium, potassium, magnesium and chloride were measured according to **[13], [14].**

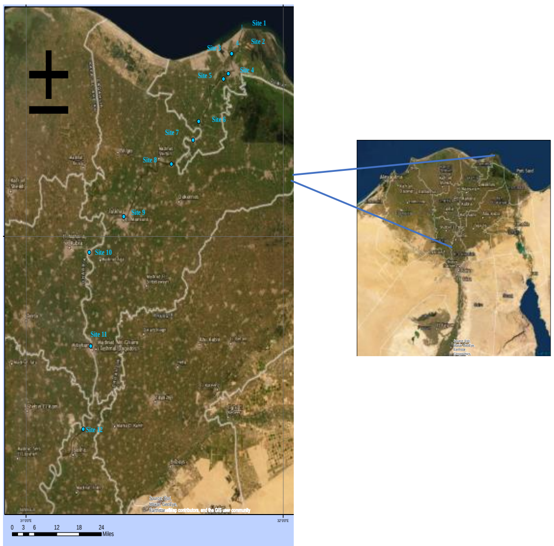

Fig. (1): *Geographic Map of the Nile Delta, showing the study area (Damietta Branch) different 12 ecological sites.*

Table (1): The ecological sites of the study area along Damietta Branch.

Site	GPS Location		Location
1	N 31 31 35.7	E 31 50 38.2	Ellesan / Ras Elbr
2	N 31 29 09.9	E 3149 27.2	Ras Elbr / Elgerby
3	N 31 27 30.6	E 31 48 01.2	The intersection of the navigation channel with the Nile
4	N 31 24 30.3	E 31 47 13.6	Damietta Dam Region
5	N 31 23 42.5	E 31 46 07.1	Eladlia
6	N 31 17 19.2	E 31 40 20.6	Shrbas / Faraskoor
7	N 31 14 30.7	E 31 39 00.9	Elsero/Elzarqa
8	N 31 10 53.6	E 31 33 58.2	Bosat Kareem Eldein / Sherbein
9	N 31 02 58.2	E 31 22 49.8	Talkha
10	N 30 57 32.9	E 31 14 48.2	Smnood
11	N 30 43 21.2	E 31 15 07.2	Meit Ghmr
12	N 30 30 45.0	E 31 13 22.5	Kafr Shokr

B. *Determination of Sodium adsorption ratio (SAR)*

From the water data, we calculated the following parameter, Sodium adsorption ratio (SAR) according to Razzak **[15]**.

As $$\mathbf{SAR} = \frac{Na}{\sqrt{\frac{Ca+Mg}{2}}}$$

Where:
Na^{+} = sodium ion concentration in epm.
Ca^{++} = calcium ion concentration in epm.
Mg^{++} = magnesium ion concentration in epm.

C. *Determination of Exchangeable sodium percentage (ESP)*

Exchangeable sodium percentage (ESP) was calculated also according to Razzak **[15],** using the following equation**:**

$$\mathbf{ESP} = \frac{100+(-0.0126+0.01475\,SAR)}{1+(-0.0126+0.01475\,SAR)}$$

D. *Determination of the percentage of sodium*

The percentage of sodium can be determined using the following formula, **[16].**

$$\mathbf{Na\ \%} = \frac{Na+}{Ca+Mg+K+Na}\ x\ 100$$

E. *Determination of Potassium adsorption ratio (PAR)*

Potassium adsorption ratio, calculated from the following equation, **[17]**.

As $$\mathbf{PAR} = \frac{K}{\sqrt{\frac{Ca+Mg}{2}}}$$

In which: K^{+} = potassium ion concentration, in epm

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 04, April-2021

III. RESULTS AND DISCUSSIONS

A. Determination of pH value

The pH values of surface water of the Nile River-Damietta Branch during different seasons are shown in Fig. (2). The pH value of surface water of Damietta Branch ranged from 7.6 during winter to 8.3 during summer, while annual mean values of pH varied between 7.1 at Kafr Shokr and 9.1 at Talkha,**.** During the winter season, water acidity increases in cold weather as a function of increased carbonic acid content that develops in the water when phytoplankton consume less carbon dioxide, **[18]**, **[19]**. The obtained result was similar to that recorded by **Badr [20].** He reported, values of pH ranged from 7.15 to 8.80, with an average value of 7.93 ± 0.33 and were significantly higher in spring and summer relative to autumn and winter. This may be due to the photosynthetic activity of phytoplankton which removes CO_2 from the water. Generally, water streams have a pH ranging, between 6 and 9, and any changes in this range in pH can affect life-forms in aquatic systems. If the pH increases above this range, smaller amounts of ammonia are needed to reach a level that is toxic to fish, while when the pH decreases, the acidity of the water increases, affecting the fish, **[21].** The obtained results were also in agreement with those found by **[19]**.

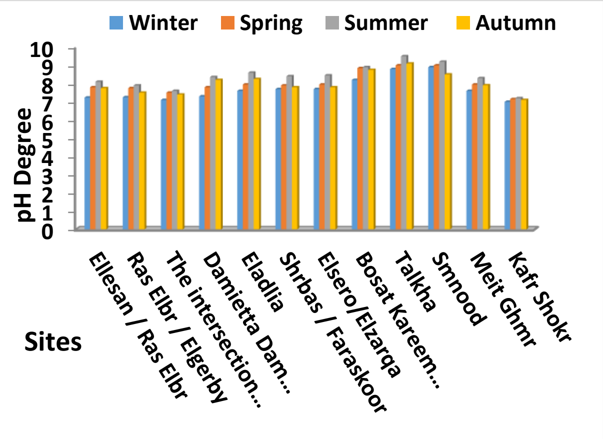

Fig. (2): *Seasonal variations of pH of surface water of Nile River-Damietta Branch*

B. Determination of Salinity and EC

Salinity acts as a key component of life in the aquatic system. It is an important factor which reflects the changes caused by the mixing between fresh water, drainage water and seawater. **Schulz** and **Cañedo [22]**, defined salinity as composed of multiple major ions that alter the sensitivity of freshwater species.

The salinity of water of the Nile River along Damietta Branch is shown in Fig. (3). The salinity value of water of the Damietta Branch ranged from 25.7±3.3‰ at Kafr Shokr station to 41.7±2.8‰ at Ellesan / Ras Elbr station. This high value is thought to be due to the flow of water from the sea (water intrusion phenomena). Seasonal mean values of salinity varied between 30.6±6.7‰ during spring and 37.4±5.8‰ during summer, (Fig.3). The rest stations have lower and in between values, with the exception of Talkha, which has a relatively high and cloth value to that of Ellesan/Ras Elbr, (39.52.7). However, this could be attributed also to seawater intrusion, a phenomenon that appeared after the construction of Faraskour dam. So, we can say that the Faraskour dam acts as an artificial barrier which

prevents natural equilibrium between Damietta Branch an d the Mediterranean Sea, **[23]** and that appeared clearly in the result. Agriculture can produce highly saline irrigation return flows that enter freshwater. The main drivers of river and stream salinization are the anthropocene, human activities, and land clearing.

One of the most important thermo physical properties of river water is its electrical conductivity (EC), which maintains almost a linear relationship with total dissolved solids, **[24]**. EC is related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulfides and carbonate compounds. The more ions that are present, the higher the conductivity of water. Electrical conductivity (EC) of water of the Nile River along Damietta Branch is shown in Fig. (3). The electrical conductivity (EC) value of water along Damietta Branch ranged from 16.3±5.7 mS/cm at Meit Ghmr station to 46.9±3.2 mS/cm at Ellesan/Ras Elbr station while seasonal mean values of electrical conductivity (EC) varied between 34.1±14.4 mS/cm during spring and 44.3±13 mS/cm during summer, (Fig.3). This result can be explained through the effect of temperature, climatic change and intrusion of sea water. Abdo**, [25]** reported in his investigation that salinity was not detected at all fresh water investigated stations along Damietta branch during different seasons, although the mean value of salinity and EC were close to the current study. These findings are consistent with those of **[25], [26]**. Hannigan **[27]** reported that when water temperature increases, so will conductivity. For every 1°C increase, conductivity values can increase 2-4%. Temperature affects conductivity by increasing ionic mobility as well as the solubility of many salts and minerals. Seasonal variations in conductivity, while affected by average temperatures, are also affected by water flow. In some rivers, as spring often has the highest flow volume, conductivity can be lower at that time than in the winter despite the differences in temperature. In water with little to no inflow, seasonal averages are more dependent on temperature and evaporation.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 04, April-2021

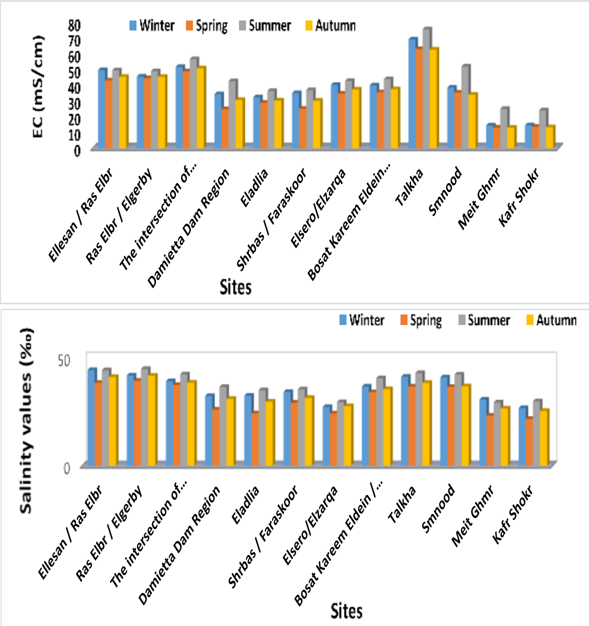

Fig. (3): Seasonal variations of Salinity (‰) and EC (mS/cm) of surface water of Nile River-Damietta Branch

C. Determination of Solids in water (TDS, TSS and TS)

Total dissolved solids (TDS), total suspended solids (TSS) and total solids (TS) were determined in river water along Damietta branch, Fig. (4). The total dissolved solids value of water along Damietta Branch ranged from 12.4±4 g/l at Meit Ghmr and Kafr Shokr stations to 40.3±2.7 g/l at Ellesan/Ras Elbr station. This high value is thought to be due to the flow of water from the sea (water intrusion phenomena), **[28]**. In Fig. (4), seasonal mean values of total dissolved solids varied between 25.3±9.4 g/l during spring and 33.2±8.1 g/l during summer.

The total suspended solids value of water along the Damietta branch, on the other hand, ranged from 4.80.6g/l at Bosat Kareem Eldein/Sherbein station to 53.64 g/l at Ras Elbr/Elgerby station, with a very clothes value of 53.14% at Ellesan/Ras Elbr station.While seasonal mean values of total suspended solids varied between 25.5±16g/l during spring and 29.4±16.7 g/l during summer, (Fig.4)

In the same way, (Fig.4), seasonal mean values of total solids varied between 52.7±18.1 g/l during spring and 58.9±19.6 g/l during summer and very clothing value in the winter (58.6±20.5 g/l). But the total solid annual value of water along the Damietta branch ranged from 38.4±3.9 g/l at Shrbas/Faraskoor station to 93±6.1g/l at Ellesan/Ras Elbr station.

In addition to intrusion of sea water which causes the high increase in these parameters values, **[29]** especially in site 1 and 2 with unusual increase, the low water level in the Damietta branch during the winter period and the increasing rate of water evaporation in summer causes an increase in the concentration of these parameters in seasonal mean value in summer and winter of the current study period, **[19]**. The Effect of TDS on irrigational water according to Ayers **[30]** and from the current result shows that the TDS of Damietta branch water causes severe problems as its value exceeds 1920 mg/l.

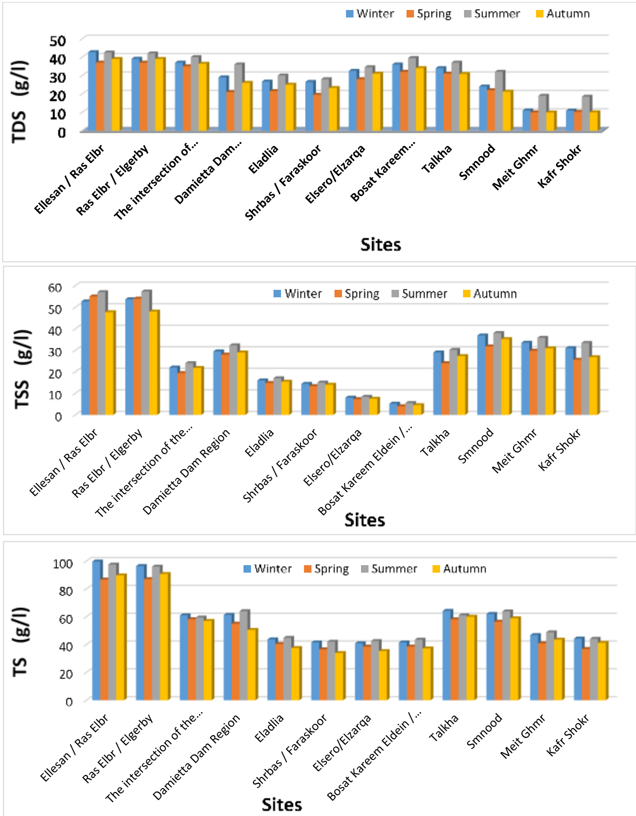

Fig. (4): Seasonal variations of TDS, TSS and TS (g/l) values in water samples along Damietta Branch - Nile River

D. Determination of salts toxicity in water

1. Determination of chloride (Cl)

Cloride (Cl) concentration value in water along Damietta Branch increased from up to downstream along Damietta branch and especially at stations one and two, it ranged from 0.14±0.001 g/l at Kafr Shokr station to 15.3±0.8 g/l at Ellesan/Ras Elbr station. This value was followed by a relatively high value at Ras Elbr/Elgerby station (14.6±0.5 g/l), (Fig.5). The rest

stations have lower and in between values, (Table 2). This was mainly attributed to the strong effect of Mediterranean Sea water mixing with Damietta branch water at these stations. The current results are in accordance with that finding by Abdo **[25],** oppositely El Sayed **[31]** confirmed the lower value of Cl where the mean value reported was 33mg/l. Seasonal mean values of Cl varied between 5.7±3.6 g/l during spring and 6.4±001g/l during summer.

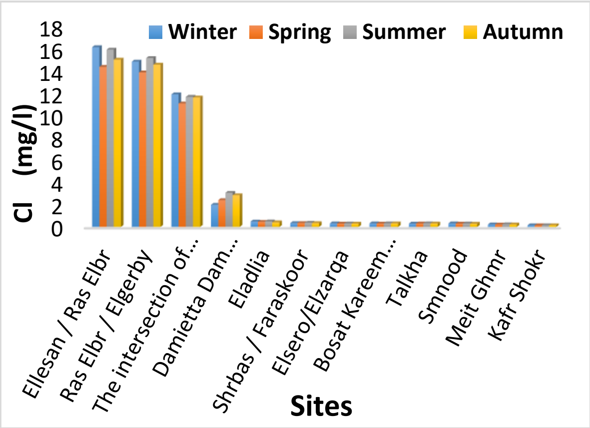

Fig. (5): Seasonal variations of Cl (mg/l) values in water samples along Damietta Branch - Nile River during 2017/2018.

2. *Sodium and Potassium concentration*

Sodium concentration value in water along Damietta Branch was distributed in a regular manner as it increased from upstream to downstream along Damietta Branch with the exception of Talkha station, which has a higher value than in the following stations, the concentration of Na decreased once more. It ranged from 21.3 mg/l at Kafr Shokr station to 399.9 mg/l at Ellesan/Ras Elbr station, (Table 2). In the same way, potassium concentration value in water along Damietta Branch was distributed in a regular manner from station1 to station 7 as it increased from upstream to downstream, then value varied between increase and decrease linear along Damietta branch. This value ranged from 22.39 mg/l at Meit Ghmr station to 287.3 mg/l at Ellesan/Ras Elbr station and this with a mean value of 143.8±117.4 mg/l along the branch, (Table 2). These results were similar to that reported by Sayed **[31], [32].**

3. *Calcium and Magnesium concentration*

On the other hand, calcium concentration value in water along Damietta Branch is distributed in an irregular manner along Damietta branch. It ranged from 0.87 mg/l at Kafr Shokr station to 5.34 mg/l at Eladlia station and this with a mean value of 2.45±1.58 mg/l along the branch, (Table 2). The magnesium concentration value in water along Damietta Branch distribution was difficult to detect as most stations have very high value and could not be detected easily. The distribution of rest stops (4 stations) is erratic. It ranged from 0.006 mg/l at Eladlia station to 0.6 mg/l at Smnood station and this with a mean value of 0.067±0.173 mg/l along the branch, (Table 2). The observed decreasing in Sodium values landward may be related to the effect of sea water intrusion. However, the increase and decrease in this ions concentration in the Damietta branch is mainly attributed to the discharge of municipal and industrial wastes, domestic wastes discharged, agriculture activity (mineral-rich fertilizers) and application of extensive irrigation in addition to seawater intrusion, [31], **[32], [33]**

4. *Percent sodium%*

The sodium percent value in water along Damietta Branch is distributed in an irregular pattern. It ranged from 16.16% at Shrbas/Faraskoor station to 8.24% at Kafr Shokr station, with a mean value of 12.6±2.1% along the branch. The rest stations have lower and in between values, (Table 2,3). The results were unexpected because station 1 and 2 were expected to have the highest value due to the strong effect of Mediterranean Sea water mixing with Damietta branch water at these stations. However, the current findings are consistent with that of Mostafa and Peters **[34],** who found that Na ions (40-110 mg/l) upstream and (21-34 mg/l) downstream had the lowest concentrations among the rest cations. They stated that this distribution was caused by agricultural runoff or natural distengrations. Water in the Damietta branch was classified as permissible water used for irrigation according to Na% which is less than 60% while there were five stations (Damietta Dam Region, Shrbas/Faraskoor, Elsero/Elzarqa, Bosat Kareem Eldein/Sherbein, Talkha) classified as doubtful water for irrigation with Na% more than 60% and less than 80%, (Table 5).

Table (3): Sodium percent water class, [33]

Sodium (%)	Water class
20<	**Excellent**
20–40	**Good**
40–60	**Permissible**
60–80	**Doubtful**
80 >	**Unsuitable**

5. *Sodium adsorption ratio (SAR)*

SAR value of water along Damietta Branch ranged from 1.72 eq/l at Smnood station to 25.55 eq/l at Ellesan / Ras Elbr station and this with a mean value of 8.2±7.4 eq/l along the branch, (Table 2). According to SAR calculations and characterizations, it is obtained that Damietta branch water is classified as medium (good water quality), (Table 4) which is suitable for coarse textured or organic soil with good permeability, relatively unsuitable in fine textured soils, **[35]**. However, different stations along the branch varied between several classes (low, medium, high and very high), (Table 5) and (Fig.6).

Table (4): Classification of irrigation water and sodium hazard based on SAR, [7].

SAR value	Water class	Quality	Suitability for irrigation
0–10	Low (S1)	Excellent	Suitable for all types of crops and all types of soils, except for those crops, which are sensitive to sodium
10–18	Medium (S2)	Good	Suitable for coarse textured or organic soil with good permeability, Relatively unsuitable in fine textured soils.
18–26	High (S3)	Fair	Harmful for almost all types of soil requires good drainage, high leaching gypsum addition
above 26	Very high (S4)	Poor	Unsuitable for irrigation

6. *Potasium adsorption ratio (PAR)*

PAR value of water along Damietta Branch ranged from 1.72 eq/l at Smnood station to 25.55 eq/l at Ellesan / Ras Elbr station and this with a mean value of 8.2±7.4 eq/l along the branch, (Table 2). According to PAR calculations and **[36],** it is obtained that Damietta branch water is classified as having low to medium risk of soil dispersion (low to medium water quality) but real risk values are for waters low in EC, typically <65mS/m). However, different stations along the branch varied between several classes (low, medium, high and very high), (Table 5) and (Fig.6).

7. *Exchangeable sodium percentage (ESP)*

ESP value of water along Damietta Branch ranged from 12.96 at Ellesan / Ras Elbr station to 68.68 at Kafr Shokr station and this with a mean value of 43.04±20.2 along the branch, (Table 2) and (Fig.6).

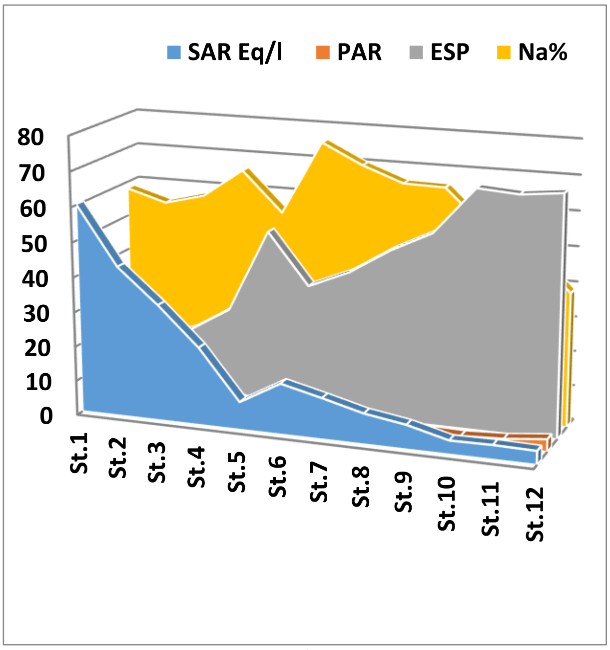

Fig. (6): Mean values of SAR, PAR, ESP, Na%

CONCLUSION

This study applied mathematical indices (SAR, PAR, ESP) that depend on the concentrations of some salts (ions) to evaluate the water quality of the Damietta branches- Nile River. The concentration of Cl and potassium was much higher and exceeded standard levels of the FAO standard for irrigation water. The studied surface water samples show medium and permissible water quality for irrigation purposes for the branch at all, which appeared to be doubtful at some stations along the branch. This study showed a progressive ecological degradation occurred along Damietta Branch at its estuaries. Hence, there should be regular and continuous monitoring for developing ecosystems of the River Nile system and its irrigation system. It is essential to confirm urgent plans for the management of Damietta branch water quality to maintain pollution levels within the permissible values. Environmental law should be developed and enforced to prevent the discharge of wastewater such as agricultural, domestic, industrial, or other sources into the Nile River system. Also, the study concluded that the mathematical indices such as SAR, PAR, ESP indices are valid to evaluate the water quality of the study area.

ACKNOWLEDGMENT

We want to express our most profound appreciation to all those who provided us the possibility to complete this research. Also, thank the support of the staff members and colleagues of the Environmental Sciences Department., Faculty of Science, Damietta University for providing the equipment and research facilities.

REFERENCE

[1] **Caro D., Alessandrini A., Sporchia F. and Borghesi S. (2021).** Global virtual water trade of avocado. *Journal of Cleaner Production*, *285*, 124917.

[2] **Ungureanu N., Vlăduț V. and Voicu, G. (2020).** Water Scarcity and Wastewater Reuse in Crop Irrigation. *Sustainability*, *12*(21), 9055.

[3] **de Lima Moraes A. G., Bocardo-Delgado E., Bowling L. C., Daneshvar F., Pinto J., Watkins A. H. and Cherkauer K. A. (2020).** Assessment of Arequipa's Hydrometeorological Monitoring Infrastructure to Support Water Management Decisions. *Journal of Contemporary Water Research & Education*, *171*(1), 27-48.

[4] **Alemu M. M. and Desta, F. Y. (2017).** Irrigation water quality of River Kulfo and its implication in irrigated agriculture, South West Ethiopia. *International Journal of Water Resources and Environmental Engineering*, *9*(6), 127-132.

[5] **Hajilar S. and Shafei B. (2018).** Structure, orientation, and dynamics of water-soluble ions adsorbed to basal surfaces of calcium monosulfoaluminate hydrates. *Physical Chemistry Chemical Physics*, *20*(38), 24681-24694.

[6] **Van Rooyen B. B. (2018).** Evaluation of the efficacy of chemical, ultraviolet (UV) and combination treatments on reducing microbial loads in water prior to irrigation (Doctoral dissertation, Stellenbosch: Stellenbosch University).

[7] **KUMAR R., CHAUDHARY S. and YADAV S. (2019).** Anthropogenic influences on the hydrogeochemistry and water quality of ground water in singrauli power belt region, central India. In *Proc Indian Natn Sci Acad* (Vol. 85, No. 3, pp. 637-658).

[8] **Pessoa L. G. M., dos Santos Freire M. B. G., dos Santos R. L., Freire F. J., Miranda M. F. A. and dos Santos P. R. (2019).** Saline water irrigation in semiarid region: I-effects on soil chemical properties. *Australian Journal of Crop Science*, *13*(7), 1169.

[9] **Farahani E., Emami H., Keller T., Fotovat A. and Khorassani R. (2018).** Impact of monovalent cations on soil structure. Part I. Results of an Iranian soil. *International Agrophysics*, *32*(1), 57.

[10] **Karroum L., El Baghdadi M., Barakat A., Meddah R., Aadraoui M., Oumenskou H. and Ennaji W. (2019).** Hydrochemical characteristics and water quality evaluation of the Srou River and its tributaries (Middle Atlas, Morocco) for drinking and agricultural purposes. *Dwt*, *146*, 152-64.

[11] **Syed A., Sarwar G., Shah S. H. and Muhammad S. (2021).** Soil salinity research in 21st century in Pakistan: its impact on availability of plant nutrients, growth and yield of crops. *Communications in Soil Science and Plant Analysis*, *52*(3), 183-200.

[12] **Tomaz A., Palma P., Fialho S., Lima A., Alvarenga P., Potes M. and Salgado R. (2020).** Risk Assessment of Irrigation-Related Soil Salinization and Sodification in Mediterranean Areas. *Water*, *12*(12), 3569.

[13] **Hasaballah F. A., Hegazy A. T., Ibrahim S. M. and Elemam A. D. (2019).** Assessment of Water and Sediment Quality of the River Nile, Damietta Branch, Egypt. *Egyptian Journal of Aquatic Biology and Fisheries*, *23*(5 (Special Issue)): 55-65.

[14] **Hasaballah F. A., Hegazy A. T., Ibrahim S. M. and El-Emam A. D. (2019).** Phycoremediation of Metal Pollution of Wastewater. *International Journal of Engineering Research & Technology (IJERT), 8(9):346-352.*

[15] **Razzak M. A., Sanjana P., Hossain M. B., Roy D. and Nath B. C. (2017).** Quality Assessment of Ashugonj Power Plant Disposal Water for Irrigation Application. ***Journal of Agriculture Search***., *4*(4), 259-263.

[16] **Guettaf M., Maoui A. and Ihdene Z. (2014).** Assessment of water quality: a case study of the Seybouse River (North East of Algeria). ***Applied Water Science***., 7(1), 295–307.

[17] **Vilela N. M. S., Thebaldi M. S., Leal B. D. P., Silva A. V. and Martins I. P. (2018)**. Transport parameters of potassium from different sources in soil columns. ***Engenharia Agrícola***., 38(1): 135–141.

[18] **Pipko I. I., Pugach S. P., Luchin V. A., Francis O. P., Savelieva N. I., Charkin A. N. and Semiletov, I. P. (2021).** Surface CO2 system dynamics in the Gulf of Anadyr during the open water season. *Continental Shelf Research*, *217*, 104371.

[19] **Mostafa M. K., *et al*. (2016).** Use of statistical analyses to assess water quality at the Damietta branch of the Nile river. ***Egyptian Journal of Environment and Biotechnology Research***., 2(1):16-26.

[20] **Badr E. S. A. (2016)**. Spatio-temporal variability of dissolved organic nitrogen (DON), carbon (DOC), and nutrients in the Nile River, Egypt. ***Environmental Monitoring and Assessment***.,188(10).

[21] **El-Sheekh M. M. (2016)**. Impact of Water Quality on Ecosystems of the Nile River Hdb of Environmental Chemistry, Springer International Publishing AG., 56: 357–386

[22] **Schulz C. J. and Cañedo-Argüelles M. (2018).** Lost in translation: The German literature on freshwater salinization. ***Philosophical Transactions of the Royal Society B: Biological Sciences***., 374(1764): 20180007.

[23] **El-Amier Y.A., Zahran M.A. and Al-Mamoori S.O. (2015).** Environmental Changes along Damietta Branch of the River Nile, Egypt. ***Journal of Environmental Science, Mansoura University***., 44: 235-255.

[24] **Pal M., Samal N., Roy P. and Biswas R. M. (2015).** Electrical Conductivity of Lake Water as Environmental Monitoring –A Case study of Rudra sagar Lake. ***Journal of Environmental Science, Toxicology and Food Technology.*** 9(3-I): 66-71.

[25] **Abdo M. H. (2010).** Environmental and Water Quality Evaluation of Damietta branch, River Nile, Egypt. National Institute of Oceanography and Fisheries, Inland Waters and Aquaculture Branch, ***African journal of Biological Science*.,** 6 (2): 143-158.

[26] **Sayed M. F. (1998).** Evaluation of pollution on *Mugil* species in Damietta branch of the River Nile between Faraskour Barrage and Ras El-Bar outlet. M. Sc. Thesis, Faculty of Science., Helwan Univ., Egypt.

[27] **Hannigan R. E., Genest D. M. and RobinsonW. E. (2018).** Chemistry of Natural Waters. ***Green Chemistry*, *Elsevier*., 235-259.**

[28] **Negm A., Abdel-Aziz T. M., Salem M. N. and Yousef W. (2017).** Morphology of the Nile river due to a flow rate over the maximum current: case study damietta branch. The Nile River. Springer, Cham., 239-257

[29] **Abdel-Satar A. M., Ali M. H. and Goher M. E. (2017).** Indices of water quality and metal pollution of Nile River, Egypt. ***The Egyptian Journal of Aquatic Research***., 43(1), 21–29.

[30] **Ayers, R. S. and Westcot, D. W. (1985).** *Water quality for agriculture* (Vol. 29, p. 174). Rome: Food and Agriculture Organization of the United Nations.

[31] **El Sayed S. M., Hegab M. H., Mola H. R., Ahmed N. M. and Goher, M. E. (2020).** An integrated water quality assessment of Damietta and Rosetta branches (Nile River, Egypt) using chemical and biological indices. *Environmental monitoring and assessment*, *192*(4), 1-16.

[32] **Abdel-Fattah M. K., Abd-Elmabod S. K., Aldosari A. A., Elrys A. S. and Mohamed, E. S. (2020).** Multivariate Analysis for Assessing Irrigation Water Quality: A Case Study of the Bahr Mouise Canal, Eastern Nile Delta. *Water*, *12*(9), 2537.

[33] **Abdel Galil M., A Hegazy T., Hasaballah F. and M Al-Madboly N. (2020).** Chemical Characteristics of the Surface Water around Ras El-Bar Island, Damietta Governorate, Egypt. *Journal of Environmental Sciences. Mansoura University*, *49*(1), 17-27.

[34] **Mostafa M. K. and Peters R. W. (2015).** Use River Pollutant Modeling to Simulate and Predict the Change in the Damietta Branch Water Quality before and after Construction of the Ethiopian Dam. ***Journal of Environmental Protection***., 6(9): 935

[35] **El-Emam D. A. (2020).** Monitoring and Assessment of Water Pollution in River Nile – Damietta Branch - Egypte. A Ph.D thesis in Science Environmental Science / Environmental Quality Monitoring Environmental Sciences Department Faculty of Science, Damietta University, Egypte

[36] **Anzecc and Armcanz. (2000)**. Australian guidelines for water quality monitoring and reporting. National Water Quality Management Strategy Paper No 7, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

[37] **Wilcox L.V. (1955).** Classification and Uses of Irrigation Waters, Washington, D.C., U.S. Department of Agriculture, 1955, Circular no. 969

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 04, April-2021

Table (2): Mean values of SAR, PAR, ESP, Na%

Site No.		Cl g/l	Ca^{++} mg/l	Na^{+} mg/l	Mg^{++} mg/l	K^{+} mg/l	SAR Eq/l	PAR Eq/l	ESP%	Na%
1	*Ellesan / Ras Elbr*	15.3	1.31	399.9	-	287.3	60.28	25.55	12.96	58.08
2	*Ras Elbr / Elgerby*	14.6	1.03	255.5	-	210.4	43.43	21.11	16.86	54.71
3	*The intersection of the navigation channel with the Nile*	11.5	2.167	286.47	-	208.06	33.57	14.39	20.61	57.67
4	*Damietta Dam Region*	2.5	2.477	205.4	-	103.8	22.51	6.715	27.68	65.9
5	*Eladlia*	0.4	5.34	108.3	0.006	85.03	8.08	3.744	51.39	54.51
6	*Shrbas / Faraskoor*	0.34	1.61	108.46	-	33.47	14.71	2.67	36.79	75.56
7	*Elsero/Elzarqa*	0.3	1.87	94.41	-	38.81	11.88	2.88	41.82	69.88
8	*Bosat Kareem Eldein / Sherbein*	3	2.39	80.4	0.056	39.7	8.85	2.58	49.09	65.6
9	*Talkha*	3	4.61	88.83	0.152	42.39	7.01	1.97	54.92	65.36
10	*Smnood*	0.29	4.76	53.76	0.6	39.34	4	1.72	68.27	54.6
11	*Meit Ghmr*	0.21	0.95	23.58	-	22.39	4.15	2.32	67.43	50.25
12	*Kafr Shokr*	0.14	0.87	21.3	-	33.09	3.93	3.61	68.68	38.54
Mean± SD		4.29 ±0.58	2.45 ±1.58	143.8± 117.4	0.067 ±0.173	95.3± 89.5	18.5 ± 18.1	8.2 ±7.4	43.04 ±2	59.2±9
MAX		15.3	5.34	399.9	0.6	287.3	60.28	25.55	68.68	75.56
MIN		0.14	0.87	21.3	0.006	22.39	3.93	1.72	12.96	38.54
Irrigation FAO standard		1.036	400	919	60	2				

Table (5): Water classification for irrigation, (ANZECC and ARMCANZ, 2000)

Site No.		SAR	PAR	Na%
1	*Ellesan / Ras Elbr*	**Very high**	**High to Very high**	**Permissible**
2	*Ras Elbr / Elgerby*	**Very high**	**High**	**Permissible**
3	*The intersection of the navigation channel with the Nile*	**Very high**	**Medium**	**Permissible**
4	*Damietta Dam Region*	**High**	**Medium**	**Doubtful**
5	*Eladlia*	**Low**	**Low**	**Permissible**
6	*Shrbas / Faraskoor*	**Medium**	**Low**	**Doubtful**
7	*Elsero/Elzarqa*	**Medium**	**Low**	**Doubtful**
8	*Bosat Kareem Eldein / Sherbein*	**Low**	**Low**	**Doubtful**
9	*Talkha*	**Low**	**Low**	**Doubtful**
10	*Smnood*	**Low**	**Low**	**Permissible**
11	*Meit Ghmr*	**Low**	**Low**	**Permissible**
12	*Kafr Shokr*	**Low**	**Low**	**Good**
Mean (Damietta branch)		**Medium**	**Low to Medium**	**Permissible**