World Journal of Fish and Marine Sciences 1 (1): 51-55, 2009
ISSN 1992-0083

Outlook on Past, Present and Future Status of Water Salinity in Lake Qarun, Egypt

Radwan G. Abd Ellah

National Institute of Oceanography and Fisheries, Egypt

Abstract: Currently, investigations on water salinity in Lake Qarun are rapidly increasing rapidly, because of the important of this lake as a resource of salts and on aquatic ecosystem. Lake Qarun is, a saline basin, located immediately northwest of Egypt (29°28.5\ N-30°37.5\ E). It is bounded on the east and south by the agricultural cultivated lands, on the north by desert. The present result showed that the water salinity is low in the eastern part of Lake Qarun and gradually increases north-westward. The lake salinity also is low in winter and high in summer. These variations in water salinity of the lake depend on the quantity of drainage water inflow and evaporation process. concerning salt budget result, about 84.54 million kg/year accumulate in Lake Qarun and lead to obvious increase of its salinity by 0.07‰ / year.

Key words: Lake Qarun % Salinity % Salt budget

INTRODUCTION

Investigations of a lake hydrochemistry and its temporal variation are increasing rapidly, because of the importance of lake as resource of salts and on aquatic ecosystem [1]. Saline lakes are often noted for their high productivity and their considerable ecological importance, particularly to endemic species and breeding migratory bird populations [2]. Salt lakes occur in arid to semi-arid environments whenever internally drained basins are formed due to tectonic activity or dissolution processes [3]. The salinity of lakes is conventionally considered to be the result of the input salt content concentrated by evaporation [4]. The main requirement for the occurrence of such a system is that, at the lake surface, free water evaporation exceeds precipitation [3]. In order to forecast the responses of a lake to further perturbations, a better understanding of its hydrochemistry (salinity) is required.

Study Area: Lake Qarun is a saline basin, located immediately northwest of Egypt. The lake is bounded on the east and south by the agricultural cultivated lands, on the north by desert. It uses as a general receptor for agricultural drainage water of the Fayoum Province. Most of this discharge is brought to the lake via the so called El-Batts and El-Wadi drains [5]. Lake Qarun is a source of salt as Sodium Chloride, Sodium Sulfate and Magnesium Sulfate [6], Fish as Solea and Tilapia [7] and tourism [8].

Lake Qarun (Fig. 1), is a closed basin, occupies the lowest pit of the Fayoum depression (29°28.5'N-30°37.5' E). It is a regular basin with along axis of about 40km, mean width of 6km, a mean depth of 4.2m, at 44 m below the sea level [9]. The lake salts content are transported through discharges of drainage water and accumulate in the lake components [10]. In 1987, the hydrochemistry ecosystem of the lake has changed as a result of EMISAL plants operating. EMISAL plant was created on its southern coast. The aim of the EMISAL project was to extract of these salts through an economically and technically efficient way.

Lake Qarun is suffering from many problems affecting all aspects of its ecosystem. One of the problems in the lake is the change in its annual salinity and consequently its salt content, which had profound effect on its fauna and flora. Several studies have been conducted on the chemistry and biology at the Lake Qarun [11-14], However, comparatively little studies evaluated the salt changes in the lake. The main objectives of the present paper were to, study the temporal and spatial water salinity variations, estimate salt budget, forecast of the salinity and determine the state of salinity in this lake.

Data and Method of Analyses: Seventeen water samples were seasonally collected from Lake Qarun during 2006. In addition to two sampling station for the main drains (El-Batts and El-Wadi drains). Whenever possible,

Corresponding Author: Dr. Radwan G. Abd Ellah,National Institute of Oceanography and Fisheries, Egypt

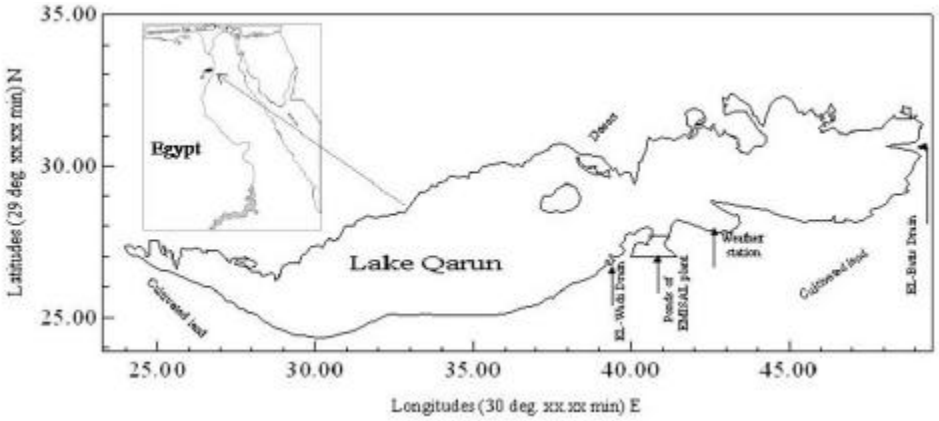

Fig. 1: Egypt and Lake Qarun map

salinity samples from the ground water were randomly taken from the vicinity of the lake. The total dissolved solids were measured by filtration of sample through Millipore filter (0.45µ pore diameter) in an oven at 105°C for 24 hour [15].

Mathematical framework for the salt budget in the lake was established by the variation of salt mass in lake result of salt accumulation from inlet minus salt outlet [1-2]. Concerning to the results of the hydrological budget of Lake Qarun [9], the salt budget of Lake Qarun is expressed by:

$$S_I + S_G - S_P = \Delta S_Q \quad (1)$$

Where, S_I is the dissolved salts input by the main drains discharge to the lake, S_G is the dissolved salts input through ground water, S_P is the salt outflow by water pumping to EMISAL ponds and ΔS_Q is the change in salt content of the lake.

RESULTS

The spatial and seasonal variations of the water salinity in Lake Qarun are shown in Fig. 2. The change in water salinity is obvious. The lake salinity range from 29.2-35.4‰ in winter, 27.1-36.2‰ in spring, 29.3-38.0‰in summer and 29.7-35.4‰ in autumn.

Concerning the salt budget (Fig. 3), the input via the main drains (salinity of 1.0 ‰) is 419.56 million kg/ year and the ground water (salinity of 1.02‰) is 70.36 million kg/year. The output part of the salt budget comprises the volume of flow from the Lake to EMISAL plant (salinity of 34.5‰), which is 405.38 million kg/year.

DISCUSSION

The seasonal spatial variations in water salinity of Lake Qarun are obvious. The water salinity is low in the eastern part of the lake and gradually increased north-westward. This result is due to discharging of the drainage water via El-Batts Drain at east and the absence of water sources from northern side [16]. Also, the lake salinity is low in winter and high in summer. These seasonally variations in water salinity of a lake depend on the quantity of drainage water inflow and evaporation process [4, 10, 16-20].

The storing of agricultural drainage water in the lake lead to increases of its salinity by time depending on the climate conditions (evaporation) of the area [3]. The variations in water salinity over the past century were obvious (Fig. 4) and can be divided into two periods. First before the year 1987 , whereas, the fluctuated Lake salinity was obtaining (13.3 to 34.48‰) [21-22]. Second from the year 1988 till now, after EMISAL plant is operating, the water salinity is somewhat fixed and becomes around 34.5‰.

The above annually variations in Lake Qarun salinity are inaccurate, due to the difference in methods of analyses and also the sampling collection (number of samples and their locations). Therefore the salt budget is considered to be the accurate method for determine the annually water salinity variation in the lake.

According to the salt budget of the lake, the output part of the salt budget comprises turned out to be less than the input by 84.54 million kg/year. This surplus part accumulates in the lake and lead to increase of its salinity by0.07‰/year. The increasing of water salinity

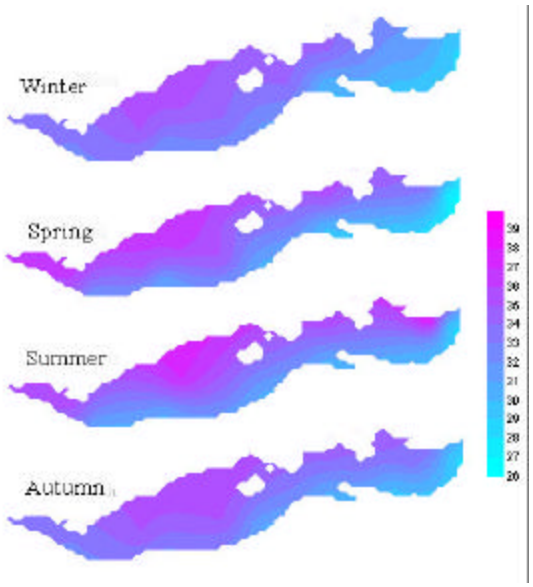

Fig. 2: The spatial variation of the water salinity in Lake Qarun

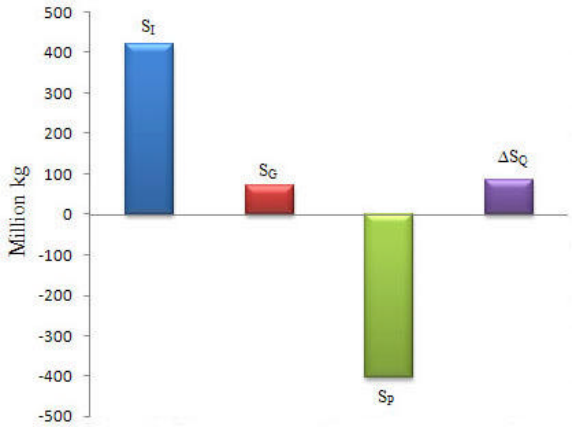

Fig. 3: The components of the salt budget in Lake Qarun
S_I is the dissolved salts input by the main drains, S_G is the dissolved salts input through ground water, S_P is the salt outflow by water pumping to EMISAL ponds and ? S_Q is the change in salt content of the Lake

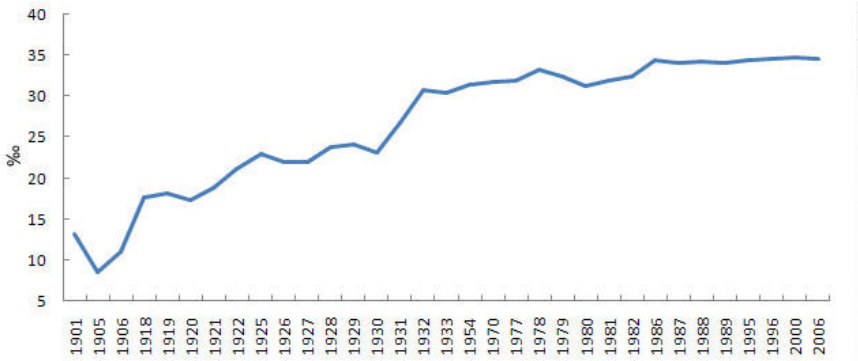

Fig. 4: The mean annually water salinity in Lake Qarun

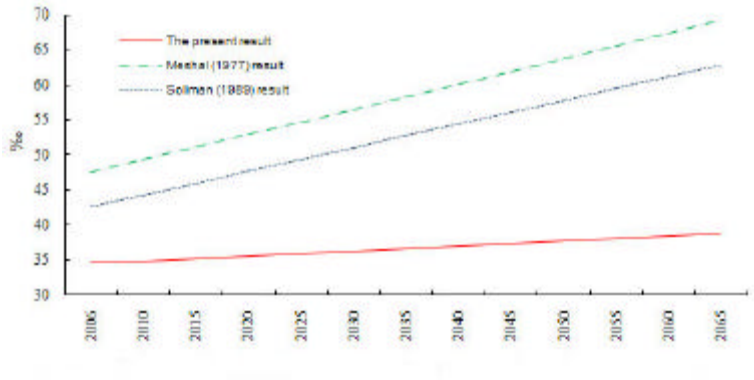

Fig. 5: The forecasted water salinity in Lake Qarun

in Lake Qarun is obvious in the present study and in all other previous studies [5, 8, 10, 12, 16], but the ratios imply changes; 0.35‰/year [21] and 0.33‰/year [22]. This change in the variation ratio can be, attributed to extract dissolved salts from the lake to EMISAL Plant.

Looking forward and using of the current result to forecast the future evaluation the lake, the salinity should considerably increase. Recently pumped water from the Lake to EMISAL plant has helped to reduce the amount of water salinity in the lake somewhat, but the problem of variation still exists. The third purpose is to demonstrate the use of the salt budget result to predict the long term influence of future policies on the lake salinity. The salt content and average salinity which are expected in future may be calculated on the assumptions that:

- Lake Qarun water storage appears relatively stable.
- The annual salts discharge via the main drains is taken as 419.56 million kg.
- The annual ground water provide of 70.36 million kg.
- The annual extracted salt by the EMISAL plant is of 405.38 million kg.

Figure 5 shows averages of water salinity in Lake Qarun, which is forecasted in the period from 2006-2066. The present result is absolutely lower than the result of [21-22].

Assuming the salinity in the lake is indeed at steady-state concentration, thus, the total annual inputs is taken to be equal to the outputs. For another meaning the flux of salts into the lake via main drains and ground water must be equal to salts out the Lake by pumping to EMISAL plant. In reality, the control by increasing or decreasing in the two items; salt gain through the ground water to the lake to be practically impossible. On the other side, the control in water discharge via the main drains is also very difficult, that must be change in all Fayoum irrigation system. Therefore the extracted salts from the lake in the present time are considerably the only key for stability of the lake salinity. This conception may be achieved by extension in EMISAL plant or to crate at new salt extraction plant, especially in the western and northern side of the lake.

It could be concluded that, Economically, Lake Qarun is important as a source of salts, minerals, fish and biochemical products. The lake salinity is balance between inputs and outputs. Since all inflows contain significant concentrations of salts and evaporating water none, salts accumulate in the lake itself. The variation in dissolved solids concentration threatens the lake ecosystem and the fish that depend on this ecosystem. Study of past, present and future water salinity is considered as a crucial tool for studying aquatic ecosystems and finally of the understanding of chronological changes in the Lake Qarun ecosystem.

ACKNOWLEDGMENT

The present study was done in the framework of plan of National Institute of Oceanography and Fisheries “Survey and ecological studies of Qarun and Wadi El-Rayan Lakes”. I wish to express my thanks to Engineer A. El-kordy and EMISAL Staff members for care and kind help.

REFERENCES

1. Chikita, K.A., M. Nishi and K. Hamahara, 2004. Hydrological and chemical budget in a Volcanic Caldera lake: Lake Kusshara, Hokkaido, Japan. J. Hydrol., 291: 91-114.

2. Jellison, R., Y.S. Zadereev Y. and G. Zambrana, 2004. Conservation and management challenges of saline lakes: a review of five experience briefs. Lake Basin Management Initiative. Thematic review, pp: 28.
3. Yechieli, Y. and W. Wood, 2002. Hydrologic processes in saline systems: Plays, Sabkhas and saline lakes. Earth-Science Rev., 58: 343-365.
4. Barjaktarovic, L. and L. Bendell-Young, 2002. Factors contributing to the salinity of lakes, Riske Creek region, south-central British Columbia, Canada. J. Applied Geochem., 17: 605-619.
5. Mansour, S.A. and A. Sidky, 2003. Ecotoxicological Studies. 6. The first comparative study between Lake Qarun and Wadi El-Rayan wetland (Egypt), with respect to contamination of their major components, Food Chem., 82: 181-189.
6. Abd Ellah, R.G., 2003. Chlorinity/ Conductivity ratio/ Salinity relationships of Lake Qarun water (Egypt). Bulletin National Institute of Oceanography and Fisheries, Egypt, 29: 441-450.
7. El-Shabrawy, G. and N. Khalifa, 2007. Seasonal and long term changes of macrobenthos in Lake Qarun, Egypt. J. Egyptian Academic Soc. Environ. Develop., 8(3): 1-15.
8. Anonymous, 2005. National report on hunting. Building capacity for sustainable hunting of migratory birds in Mediterranean third countries. Project reference: life o4TCY/INT/000054, pp: 57.
9. Abd Ellah, R., 2009. Using Hydrological and Meteorological data for Computing the Water Budget in Lake Qarun, Egypt. World J. Fish Marine Sci. (In Press).
10. FWMP, 1999. Fayoum Water Management Project II 'Salinisation Monitoring of Lake Qarun between 1901 and 199800. Technical Report No. 55: XXII, pp: 16.
11. Mageed, A., 2005. The effect of some environmental factors on zooplankton community biodiversity in Lake Qarun, Egypt. African J. Aquatic Sci., 30(2): 195-200.
12. Mansour, S.A., S.S. Messeha and M.M. Sidky, 2000. Ecotoxicological Studies. 1. Qualitative and quantitative determination of salt composition in Lake Qarun water and its sources. Egypt. J. Aquatic Biol. Fishery, 4: 271-303.
13. Sabae, S. and M.H. Ali, 2004. Distribution of nitrogen cycle bacteria in relation to physicochemical conditions of a closed saline lake (Lake Qarun, Egypt), Journal of Egyptian Academic Society for Environmental Development, (D-Environmental Studies), 5: 145-167.
14. Fishar, M., A. El-Mageed and R. Bendary, 2005. Environmental Factors affecting life cycle of benthic invertebrates in Lake Qarun, Egypt. Journal of Egyptian Academic Society for Environmental Development, (D-Environmental Studies), 6: 9-32.
15. APHA, 1995. Standard methods for the examination of water and wastewater, New York, pp: 1193.
16. Ali, M., 2002. Impact of agricultural and sewage effluents on the ecosystem of Lake Qarun, Egypt. Philphosty of Doctor Thesis, Faculty of Science, Al-Azhar University, pp: 307.
17. Kjerfive, B., C. Scheltini and H. Ferreira, 1996. Hydrology and Salt Balance in a Large, Hypersaline Coastal Lagoon: Lagoa de Araruama, Brazil. Estuarine, Coastal and Shelf Science, 42: 701-725.
18. Benduhn, F. and P. Renard, 2004. A dynamic model of the Aral Sea water and salt balance. J. Marine Systems, 47: 35-50.
19. Rodiguez, M., J. Benavente and F. Martos, 2006. Estimation of ground-water exchange with semi-arid playa lakes (Antequera region, southern Spain). J. Arid Environ., 66: 272-289.
20. Bischoff, J., I. Israde-Alcantara and W. Shanks, 2004. The springs of Lake Patzcuaro: Chemistry, salt-balance and implications for the water balance of the lake. J. Applied Geochem., 19: 1827-1835.
21. Meshal, A., 1977. The problem of the salinity increase in Lake Qarun (Egypt) and a proposed solution. J. Marine Sci., 37: 137-143.
22. Soliman, G.E., 1989. The hydrology of Lake Qarun, Fayoum Province, Egypt. Part 1: Physical environmental conditions. Bulletin National Institute of Oceanography and Fisheries, Egypt, 15: 75-92.