Fresenius Envir. Bull. 8: 133-139 (1999)

1018-4619/99/03-04/133-07 DM 2.50 + 0.30/p

AN INEVITABLE EPISODE: SALINATION OF GÖNYELİ POND (DAM)

Emine ATASOYLU*, Ufuk TANERI* and Ilkay SALIHOGLU**

*Eastern Mediterranean University, G.Magusa, TRNC

** METU Institute Of Marine Sciences, Erdemli, Icel, TURKEY

ABSTRACT

The results of recent studies at Gönyeli pond, located close to the capital of Cyprus, indicate that salination is a serious threat. The pond is among the oldest artificial lakes built in Cyprus. Its water capacity is one million cubic meters and it is basically used for irrigation purposes. A limnological study of the pond was initiated in December 1995, and monthly sampling from 1 meter depth continued till June 1997. Among others, salinity (parts per thousand, ppt) and total dissolved solids (TDS) were measured regularly. During this period, salinity and TDS of the pond increased very markedly, ie. salinity increased from 2 ppt to approximately 4.5 ppt and TDS from 2g/L to 12 g/L. Extrapolation of the data indicates that in case the salinity increase remains at the same rate, it will reach 15 ppt in 40 months and 38 ppt (Mediterranean average salinity) in 180-192 months.

KEY WORDS: Fresh water pond, limnology, arid climate, salination, total dissolved solids.

INTRODUCTION

Cyprus is located in the Eastern Mediterranean with an arid climate where evaporation always exceeds precipitation. With the exception of Turkey, like all the other riparian countries, Cyprus has a fresh water deficit. Several measures have been taken to overcome this deficit, among which it is worth to mention is the construction of artificial ponds. In Northern Cyprus, about 16 ponds were built and are already in use. Essentially all ponds are collecting precipitation water, and most of them are used for irrigation and a few for ground water supply.

Gönyeli pond, subject of this study, was constructed between April and December 1962. It lies about 2.5 km to the north of Gönyeli village (33° 21′ E and 35° 0.90′ N), and north west of the capital city Nicosia (Figure 1), but since it is within the territories of Gönyeli village municipality it is always referred to as Gönyeli pond, and by the locals with a little exaggeration it is named as `*Gönyeli Baraji*` (Gönyeli dam). The altitude of the pond is 150m. The maximum water reserve of the pond is one million cubic meters; the pond is used for irrigation. The surroundings of

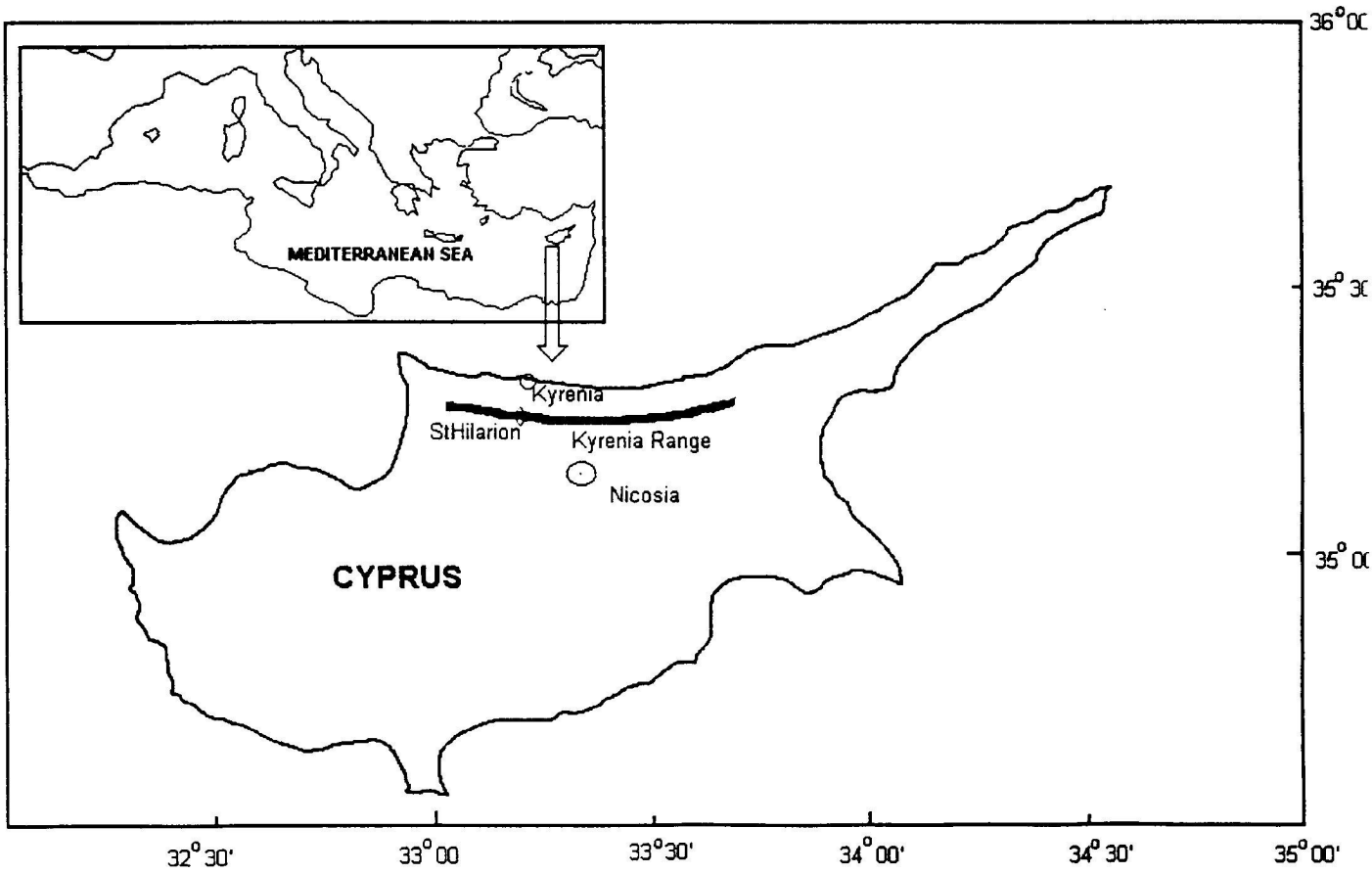

Figure 1. Location of the Gönyeli Pond.

the pond have been recently declared as a specially protected area and are no longer used for irrigation. The pond area is well within the Kythera Formation of the southern foot hills of the Kyrenia range (Figure 1). The upper part of the catchment is the Hilarion lime. The problem of silt deposition in the reservoir is important because, by nature, the Kythera Formation is highly erosive and under heavy rainfall conditions, substantial silt is transported down the river. Another problem of this Formation is the connate salts and pollutants which are washed through and contaminate the water in the river. A high percentage of boron is also reported to be present in the water (Dams of Cyprus, 1974).

The Eastern Mediterranean University with the technical support of the Institute of Marine Sciences of the Middle East Technical University initiated a limnological and coastal oceanographic program in 1995 to study the water quality of some ponds and coastal waters of North Cyprus. Among those a special emphasis was given to '*Gönyeli Barji*'. Salinity, temperature, total dissolved solids, oxidized nitrogen (NO_3+NO_2), orthophosphate (PO_4), silicic acid (reactive silicate) (H_4SiO_4), chlorophyll-a and pheopigments were measured at regular intervals. To the author's knowledge, there is no information available on this subject, neither in the literature nor in the official documents of Northern Cyprus. In this report the data on salinity and total dissolved solids are discussed in detail,since a dramatic increase in these parameters was observed in the period December 1995 to June 1997. Both increased very markedly in 19 months, and it is estimated that in a relatively short period of about four years the pond will become brakish and will not serve the purpose it was built for.

MATERIALS AND METHODS

The water samples were collected with 2.5L precleaned high density polyethylene (HDPE) containers, 1m below the surface. Chlorophyll-a samples were carried to the lab and filtered through 0.45μ pore size GF/F filters and preserved refrigerated until analysis. A 100 mL aliquot of the filtrate was used for the determination of the dissolved solids.

Water samples for analysis of NO_3+NO_2, PO_4 and silicic acid, without any treatment, were put into 50 mL HDPE bottles and kept frozen until analysis. The analytical methods were very similar to those described by Grasshof *et al.*, (1983). The quality control (QC) of the methodology was done by participating in the intercomparison exercise organized by ICES (ICES, 1995) and interlaboratory

controls. Particulates retained on GF/F filter pads were homogenized, extracted (90% acetone solution), and measured by the standard spectrophotometric method of Holm-Hansen *et al.*,(1965) for chlorophyll-a using a commercially available CHL standard (Sigma). Salinity was determined without any treatment of the samples by measuring the conductivity and temperature. The determination of total dissolved solids (TDS) was as follows: a simple filtration to avoid any particulate, then evaporation of a known volume to dryness at 180 °C.

RESULTS AND DISCUSSION

Table 1 displays the information gathered during the sampling period and Table 2 shows the meteorological and precipitation information of the region. As can be seen from Table 2, there is no steady rainfall but the months November to March/April are the months that can be wet. Most of the rainfall occurs between December and January and the rest of the year is dry and relatively hot. The average annual rainfall is 350 mm. From this short information it is clear that evaporation in Cyprus always exceeds the precipitation.

The most striking data in Table 1 can be related to the salinity and the TDS. Both increased considerably during the observation period. Initially, salinity was below 1 ‰, however, it gradually increased and reached a value above 4 ‰. This increase was verified with the TDS data (Figure 2). By definition of the salinity, it is not unexpected to see an increase of TDS with the increase of salinity. In 36 months the salinity increased five times, while TDS increased six fold. In small ponds, it is expected to observe an increase in salinity during the dry months due to evaporation, since the residual concentration increases. However in this case, the pond even in the

Table 1. Salinity, TDS, reactive silicate, orthophosphate, N_{ox} (oxidized nitrogen NO_3+NO_2) and chlorophyll-a in Gönyeli Pond measured during the sampling period (1995-1997)

DATE	SALINITY (ppt)	TDS (g/L)	Si (µm/L)	PO_4 (µm/L)	N_{ox} (µm/L)	CHL-a (mg/L)
Dec 94	-	-	6.0	-	2.20	-
Dec 95	-	-	5.70	0.70	2.30	-
March 95	0.60	1.66	9.0	0.25	7.0	-
April 95	1.00	3.61	3.25	0.25	5.30	-
May 95	0.20	1.91	2.50	0.35	6.25	-
Jun 95	0.70	4.83	4.25	0.42	0.20	-
July 95	0.72	0.20	16.60	0.46	0.20	-
Aug 95	-	-	32.00	0.38	0.60	-
Sept95	0.74	5.17	46.00	0.32	1.0	-
Oct 95	1.03	6.30	1.75	0.43	0.60	-
Nov 95	2.08	4.93	6.00	0.63	2.60	-
Jan 95	2.07	5.73				
Feb 95	1.96	5.51				
Jan 96	-	-	4.0	1.60	2.65	-
Feb 96	-	-	5.50	0.80	2.90	-
Mar 96	-	-	4.0	0.80	-	-
Apr 96	-	-	3.0	0.80	-	-
May 96	1.92	6.18	3.50	0.80	1.86	-
Jun 96	-	-	2.0	-	-	-
July 18.96	3.64	7.72	0.70	0.70	1.86	8.90
July 31.96	3.66	9.13	0.45	0.68	-	27.60
Aug 10.96	-	-	-	-	-	19.50
Aug.19.96	2.34	5.97	1.15	0.70	1.50	13.45
Aug 30.96	-	-	-	-	-	11.0
Sept.7.96	3.35	9.98	2.46	0.73	2.20	9.63
Sept.27.96	4.05	11.05	3.80	0.50	ND	9.0
Oct.12.96	4.00	9.65	1.025	10	ND	7.33
Oct.24.96	3.93	10.74	0.25	10	ND	8.26
Nov.7.96	4.59	9.52	0.33	0.50	ND	7.22
Nov.21.96	3.07	9.21	0.30	0.425	ND	4.10
Dec.7.96	3.32	10.96	0.70	0.525	-	10.12
Dec.19.96	4.47	11.28	-	0.725	-	9.50
Jan.3.97	2.38	11.50	0.35	0.66	-	11.83
Jan.17.97	4.33	11.93	0.40	0.71	-	9.57
Feb.12.97	4.43	12.00	0.62	0.52	-	8.08
Feb.27.97	4.43	12.43	0.58	0.9	-	3.86
Mar 20.97	4.34	12.57	0.45	1.19	-	14.10
Apr.8.	-	-	0.32	1.13	-	9.63
Apr.22	-	-	0.3	1.07	-	24.50
May.6.97	-	-	0.26	2.09	-	76.23
May.27.97	-	-	0.25	2.57	-	10.30
June 3.97	-	-	0.23	2.4.0	-	28.90

ND: Below the detection limit
CHL : Chlorophyll

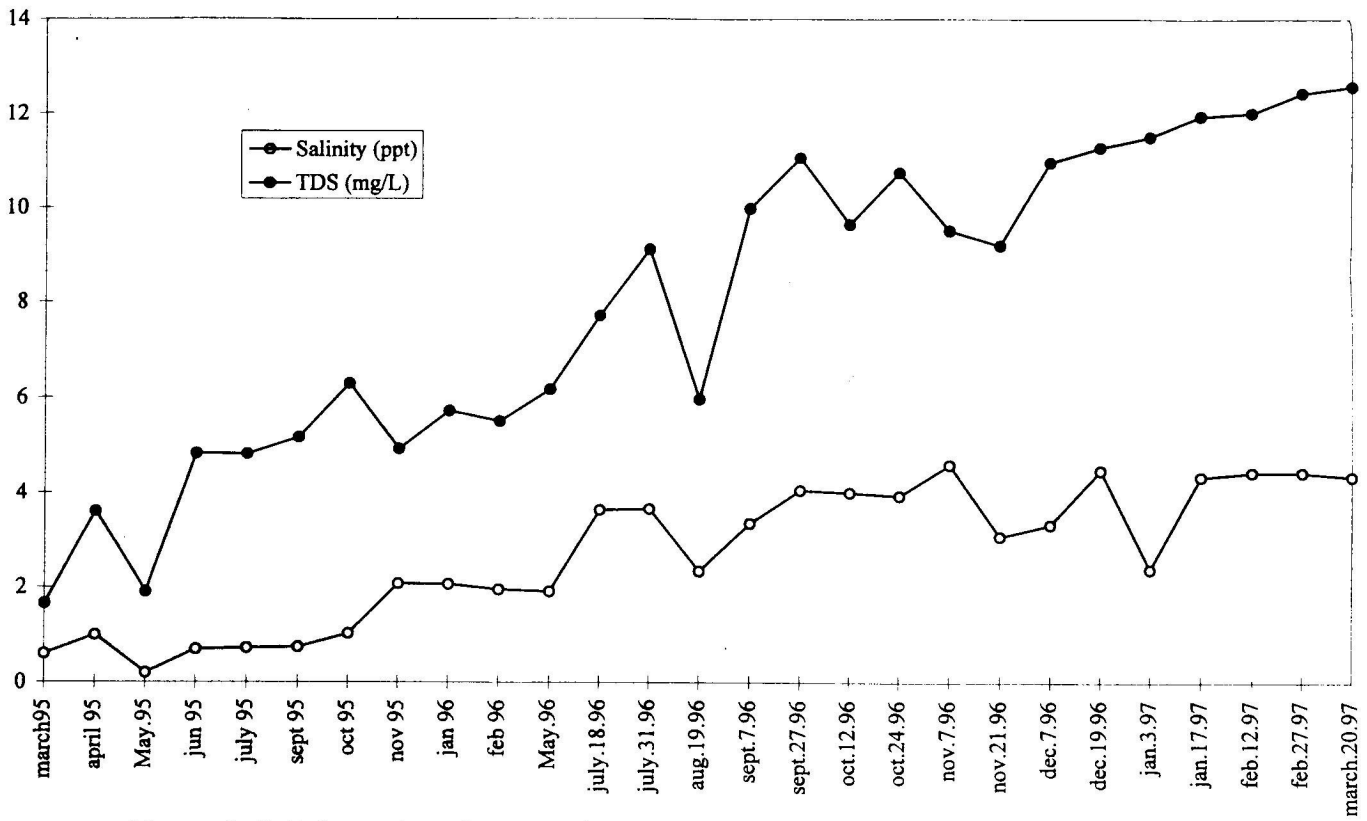

Figure 2. Salinity and TDS *versus* time of Gönyeli Pond

following relatively wet season, *i.e.* in January and February 1997, retained the relatively high salinity. This steady increase in salinity, most probably, is due to the decision to preserve the pond and its close environment as a protected area and stop using its water for irrigation. In the previous years the pond water was almost drained completely before the end of May or the middle of June in order to avoid salination. During the observation period the water was kept in the pond. Thus, high evaporation caused the accumulation of dissolved solids in the pond which appears as an increase in salinity.

The extrapolation of the data in Table 1 yields an interesting conclusion. If the salination continues at the same rate, a salinity of 15 ‰ will be reached in 40 months, which is the average value of salinity of brackish waters. The Eastern Mediterranean salinity (38 ‰) is expected in 180-192 months. Of course this is based on the assumption that the salination will follow the same trend as during the observation period. But this is not an unexpected result since, as mentioned earlier, the mineralogical structure of the drainage area is very susceptible to dissolution. Consequently this causes the accumulation of the salts in the pond and increasing of the salinity.

Table 2: Annual average meteorological conditions of N. Cyprus.

Average Values	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Max Daytime temp.(°C)	15	16	18	22	27	31	34	34	31	27	21	17
Nighttime Temp.(°C)	7	7	8	9	10	12	12	11	10	8	7	5
Hours of Sunshine Per day	6	6	7	9	10	12	12	11	10	8	7	5
% Humidity	71	71	70	65	61	59	59	61	62	64	69	71
Rainy days	9	8	7	3	2	1	1	1	1	3	5	9
Rainfall(mm)	73	52	40	24	12	-	5	3.8	2.8	22	85	28

CONCLUSIONS

Severe meteorological conditions and the geological structure of the drainage area of the Gönyeli pond make salinity a very serious threat. The water in the pond should be drained prior to intense evaporation due to the rise of air temperature, *i.e.* before June, to avoid salination and extreme ecological changes. This case study is a typical example of the mismanagement of natural resources, eventually leading to a catastrophy.

REFERENCES

Dams of Cyprus, PWD Annual report, Nicosia (1974)

Grasshof, K., Methods of Sea Water Analysis; with contribution by T.Almgreen *et.al.*, New York, Verlag Chemie, 317p., ill (1983).

State Meteorological Organization, TRNC Nicosia, (1998)

Received for publication: December 18, 1998
Accepted for publication: February 10, 1999