B2

INTERNATIONAL SYMPOSIUM ON WATER RESOURCES AND ENVIRONMENTAL IMPACT ASSESSMENT

Tel : + 90 285 3716
+ 90 285 3127
Fax : + 90 285 3139
e-mail : zsen@itu.edu.tr, sirdas@itu.edu.tr

30 March, 2001

Dear Dr. M.Irfan YESILNACAR,

We are happy to inform you that your abstract " Seasonal Variations of the Water Quality of Ataturk Dam Lake" has been accepted for presentation in the International Symposium on Water Resources and Environmental Impact Assessment. Please abide by the attached guidelines for the authors and send the paper before 11 May, 2001 in the form of hard copy with the diskette in the Microsoft Word format.

Thank you for your contribution and we hope to see you here in İstanbul during the symposium.
Yours sincerely

Zekai Şen
Symposium Chairman

P.S. For your hotel reservation you can contact the following tourism agency.

DEKON TOURISM TRADE & INDUSTRY INC.
Cumhuriyet Caddesi
Atman Apt. 259/1
Harbiye, İstanbul
Turkey

Tel : + 90 212 233 4150 (Pbx)
Fax : + 90 212 219 9150
e-mail : dekon@dedeman.com.tr
web-site: www.dedeman.com.tr

SEASONAL VARIATIONS OF THE WATER QUALITY OF ATATÜRK DAM LAKE

MUSTAFA S. YAZGAN
İstanbul Technical University, Environmental Engineering Department, Maslak, 80626, İstanbul
BÜLENT ARMAĞAN
İstanbul Technical University, Environmental Engineering Department, Maslak, 80626, İstanbul
M.İRFAN YEŞİLNACAR
Harran University, Environmental Engineering Department, Şanlıurfa

ABSTRACT

In this study, water quality of Atatürk Dam Lake, the largest fresh water resource of Turkey and Middle East region, was evaluated. Monthly water samples were analyzed for some water quality parameters between the years of 1996 and 1999. Water qualities were evaluated according to the Classification of Intra-Continent Water Supplies in Turkish Water Pollution Control Regulations and Bulletin of Technical Methods. Seasonal variations of the water quality were evaluated for some physical, chemical and microbiological parameters. From the eutrophication view, the water quality is low and the values measured are commonly higher than the limits. Total nitrogen and phosphorus have high values and indicate an increasing trend for the years. The input of these parameters must be controlled for the protection of the trophic level of the lake. Quality of water fulfills the irrigation standards in general and irrigational water quality class is determined as C2S1. For irrigation purposes, the water must be used carefully as considering the desertification problem, although it has high quality. Amount of coliform bacteria is an important problem for the lake. It has an increasing trend because of wastewater discharges and must be controlled from the view of bacteriological pollution.

KEYWORDS: *Atatürk Dam Lake, eutrophication, irrigation water, water quality*

1. INTRODUCTION

Southeastern Anatolian Project (GAP) is the most important integrated development project of Turkey and also of Middle East region. The project consists of a lot of sub-projects on irrigation, energy production, agriculture, forestry, education and health sectors. For irrigation and energy purposes, 22 dams and 19 hydroelectric power plants was planned to be constructed on Fırat (Euphrates) and Dicle (Tigris) Rivers and to irrigate the agricultural fields of 1.7 million ha, 20 % of total irrigational agricultural fields of Turkey. Total annual energy production is 27 billion kilowatt hour, 22 % of total electric energy production of Turkey. Project has also investments on transportation, tourism, urban and rural substructure. Total cost of the project is calculated as 32 billion US dollars. The project is partially under construction and some of the dams and hydroelectric power plants have completed. The starting time of the project was the beginnings of 1980's and the completing time of all components is expected to be in 2010.

Atatürk Dam, one of the completed dams, is the most important component of Southeastern Anatolian Project (GAP). It was constructed on Fırat River as a major unit of Southeastern Anatolian Project (GAP) in 1992. The lake of the dam having storage volume of 48.5 billion m^3, surface area of 812 km^2 and basin area of 92 338 km^2 is the biggest fresh water source of Turkey. It is also significant lake of Middle East Region because of the importance of drinking water in the region. This importance will be expected to increase in near future due to the cost of oil-water balance in the region.

The water of the lake is used for the purposes of drinking water, agricultural irrigation, fishery and recreational activities, at existing situation. The catchment area of the lake is covered with large agricultural areas and cities. Pollution loading from these sources has a great importance on the water quality of the lake. After the beginning of irrigation in all agricultural areas of the project, some major environmental problems related with the water quality are expected to be faced:

1. As a result of extensive agricultural activities and use of fertilizers, nutrients loading from catchment area of the lake will increase the trophic level of the lake. The water quality of the lake will be declined and the purposes of the use will be reduced.

2. Pesticide loading from the catchment area will destroy the quality of the water and the toxicity of the pesticide will affect all organisms using the water or living around the lake.
3. Wastewater loading from the residential areas in the catchment areas will also decrease the drinking water quality.

Nowadays, it is well known that some part of the Lake of Keban Dam, previously constructed dam of the same project, has a high trophic level because of extensive agricultural activities and use of fertilizers around the lake (Topkaya, 1984).

The purpose of this study is to establish the water quality of Atatürk Dam Lake. Water samples were taken for each month and analyzed for water quality parameters for the years of 1996, 1997, 1998 and 1999. Seasonal variations of the water quality were evaluated for some physical, chemical and microbiological parameters for the year of 1999. SAR values and irrigational quality classes were also calculated. Additionally, quality of water was discussed for recreational purposes.

2. METHODS

Water samples were taken for each month, when available, from the surface of the lake, approximately 1 m depth. Each sample was analized for the parameters of temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), suspended solids (SS), total alkalinity, phenolphthalein alkalinity, chloride, NH_3-N, NO_2-N, NO_3-N, organic matter, total hardness, orthophosphate, sulfate, carbon dioxide, Fe, Na, K, Ca, Mg, F, Total coliform, Esheria coliform and Fecal streptococcus by using standard methods. Sodium adsorption ratio (SAR) values and irrigational quality classes were calculated.

Water qualities were evaluated according to the Classification of Intra-Continent Water Supplies in Turkish Water Pollution Control Regulations and Bulletin of Technical Methods.

3. WATER QUALITY OF THE LAKE

3.1. Classification of water quality

The classification of water quality in the Water Pollution Control Regulation and the measured values of Atatürk Dam Lake is given in Table 1.

Table 1. The classification of water quality of Water Pollution and Control Regulation and its comparison with the quality of Atatürk Dam Lake

	Water quality class				Water quality data of the lake and their class			
	I	II	III	IV	1996	1997	1998	1999
Physical and inorganic-chemical parameters								
Temperature (°C)	25	25	30	> 30	25,50 (II)	25,67 (II)	19,29 (I)	19,42 (I)
pH	6,5-8,5	6,5-8,5	6,0-9,0	< 6 – 9 >	8,26 (I)	8,38 (I)	8,26 (I)	8,52 (II)
Chloride (mg/l)	25	200	400	< 400	25,52 (II)	31,19 (II)	29,24 (II)	25,66 (II)
Sulfate (mg/l)	200	200	400	> 400	34,59 (I)	35,87 (I)	33,82 (I)	34,62 (I)
NH_3-N (mg/l)	0,2	1	2	> 2	0,22 (II)	0,48 (II)	0,27 (II)	0,24 (II)
NO_2-N (mg/l)	0,02	0,01	0,05	> 0,05	0,00 (I)	0,00 (I)	0,00 (I)	0,00 (I)
NO_3-N (mg/l)	5	10	20	> 20	0,11 (I)	0,82 (I)	1,88 (I)	2,80 (I)
TDS (mg/l)	500	1500	5000	> 5000	213,75 (I)	231,00 (I)	225,38 (I)	215,67 (I)
Na (mg/l)	125	125	250	> 250	4,76 (I)	15,29 (I)	10,52 (I)	9,66 (I)
Organic parameters								
Organic Carbon (mg/l)	5	8	12	> 12	1,43 (I)	1,51 (I)	1,55 (I)	1,53 (I)
Inorganic pollution parameters								
F (µg/l)	1000	1500	2000	> 2000	410 (I)	270 (I)	510 (I)	600 (I)
Fe (µg/l)	30	1000	5000	> 5000	0 (I)	0 (I)	0 (I)	0 (I)
Bacteriological parameters								
Fecal colifor. (EMS/100 ml)	10	200	2000	> 2000	25 (II)	25 (II)	30 (I)	297 (II)
Total coliform (EMS/100 ml)	100	2000	10000	> 10000	160 (II)	160 (II)	180 (II)	2626 (III)

Physical and inorganic properties of the water show that the lake has high quality water generally. pH, sulfate, NO_2-N, NO_3-N, TDS and sodium values are in the first class and temperature and chloride values are almost in the first class. The concentration of NH_3-N is also approximately close to the first class however it reflects the fresh discharge of wastewater. While other organic and inorganic parameters are in good agreement with the regulations, bacteriological pollution is a major and developing problem of the lake. Especially, total coliform data of 1999 is quite high and indicate an important amount of domestic wastewater discharge.

For the control of eutrophication, limit values in Water Pollution and Control Regulation of Turkey and their comparison with the values of Atatürk Dam Lake is given in Table 2.

Table 2. Limit values for eutrophication control in Water Pollution and Control Regulation and their comparison with the quality of Atatürk Dam Lake

Parameters	Purpose of the use		Water quality of the lake			
	Natural protection area	Various uses	1996	1997	1998	1999
PH	6.5-8.5	6-10.5	8,26	8,38	8,26	8,52
COD (mg/l)	3	8	-	-	-	-
DO (mg/l)	7.5	5	-	8,5	-	-
SS (mg/l)	5	15	26,00	27,67	28,33	24,01
Total coliform (EMS/100)	1000	1000	160,00	160,00	180	2626
Total N (mg/l)	0.1	1	0,33	1,30	2,15	3,04
Total P (mg/l)	0.005	0.1	0	0	0,1	0,1

From the view of eutrophication, the water quality is low and the parameters different from pH are commonly high. Suspended solids values are quite great values of both purposes of use probably due to the solid matter, which are transported by the flow of the river and its streams. While the amount of total coliform is low enough until the year of 1999, results of the last year shows an explosively increasing in the coliform population. Total nitrogen and phosphorus, the most important two parameters for the eutrophication of a lake, have also high values and indicate an increasing trend.

3.2. Irrigation water quality

Irrigational Water Standards of Turkish Ministry of Environment has been published under “Technical Procedures Decree” in Official Gazette on January 7, 1991. The Classification of the irrigation waters in accordance with the mentioned standards and the classes of the lake water are presented in Table 3.

Commonly, irrigational quality of the water is in the first class except for electrical conductivity, suspended solids and fecal coliform values. Boron, major toxic element for the plants and human beings, was not detected in the lake water. SAR, RSC and Na values are in acceptable limits. Water class of the lake is determined as C2S1 meaning

that SAR values are low enough and electrical conductivities are good enough even it is in the second class. This type of water is accepted as a high quality water and can certainly be used in irrigation of agricultural plants.

Table 3. Irrigation water quality criteria for classification of the irrigation waters

Quality Criteria	1st class Very good	2nd class Good	3rd class May be use	4th class Use with care	5th class Hazardous	Water class of the lake water (1999)
PH	6.50-8.50	6.50-8.50	6.50-8.50	6.00-9.00	<6.00, 9.00>	1
ECx10^6 (μmhos-cm)	0-250	250-750	750-2000	2000-3000	>3000	2
Total salinity mg/l	<175	175-525	525-1400	1400-2100	>2100	-
Temperature ^{0}C	30	30	35	40	>40	1
SO_4 (me/l)	0-4	4-7	7-12	12-20	>20	1
Cl^- (me/l)	0-4	4-7	7-12	12-20	>20	1
B (mg/l)	0.050	0.50-1.12	1.12-2.00	2.00	-	1
Na %	<20	20-40	40-60	60-80	>80	1
SAR	<10	10-18	18-26	26	-	1
RSC (me/l)	<1.25	1.25-2.50	2.50	-	-	1
Salinity- sodicity	C1S1	C1S2-C2S2 C2S1	C1S3-C2S3 C3S1- C3S3 C3S2	C1S4-C2S4 C3S4-C4S3 C4S2-C4S4	-	1
Fecal Colifor. 1/100 ml	0-2	2-20	20-10^2	10^2-10^3	>10^3	3
BOD_5 (mg/l)	0-25	25-50	50-100	100-200	>200	-
SS (mg/l)	20	30	45	60	>100	2
NH_3 or NH_4	0-5	5-10	10-30	30-50	>50	1

3.4. Seasonal variation of the water quality

Some of the quality parameters of the water represent a meaningful variation according to the months or years. For instance, amount of coliform bacteria, NH3-N, temperature and suspended solids are varied among the months of the year. On the other hand NO3-N and phosphorus concentrations increases according to the years as mentioned above.

Seasonal variation of coliform bacteria parameters for the year of 1999 is given in Figure 1. There is an important increase in the amount of coliform bacteria in the hottest months of the year. The increasing of wastewater discharge into the lake and the effect of temperature on the production of microbiological population may be the reason of

these phenomena. Additionally, explosive increase in August may be a result of instant wastewater discharge.

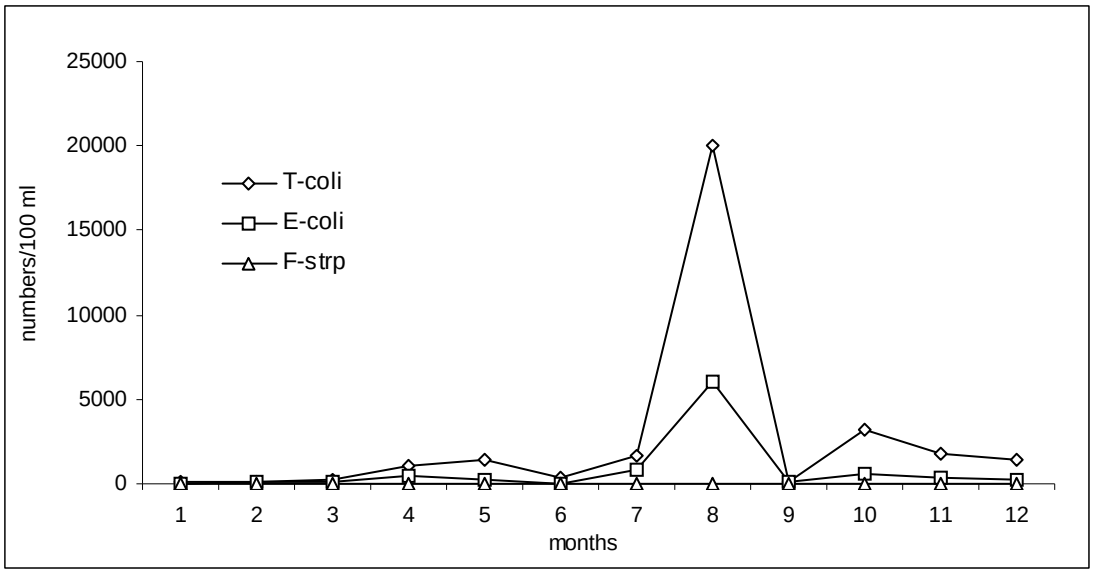

Figure 1. Seasonal variation of coliform bacteria (1999)

NH_3-N is a reflective property of fresh discharge of wastewater into the receiving media because NH_3 is readily converted into NO_3 by means of nitrification bacteria. NH_3-N values show a decrease in winter and an increase in summer season (Figure 2).

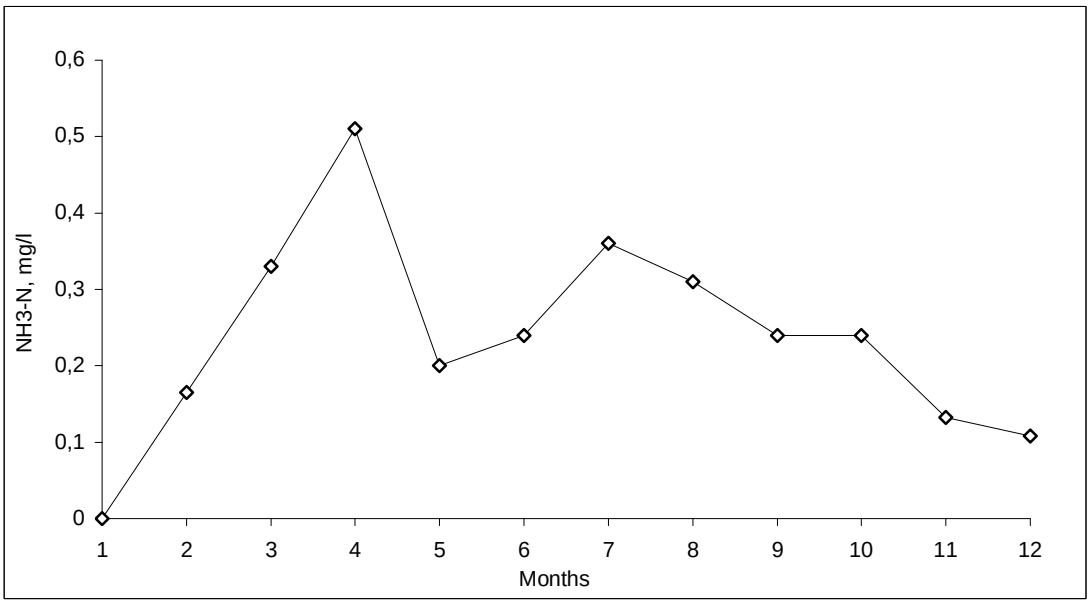

Figure 2. Seasonal variation of NH3-N (1999)

Because the sampling point is close to the dam and far from the residential areas, the NH_3 values of the lake next to these areas are expected to be higher than the measured values.

Although, the concentration of suspended solid decreases in spring and the end of winter seasons, it increases in the other months, surprisingly (Figure 3). This can be explained by the snow melting in hot season and surface flow of snow water from the catchment areas of Atatürk Dam Lake. PH of the water is almost the same during all months and temperature of the water varies with the temperature of the air apparently.

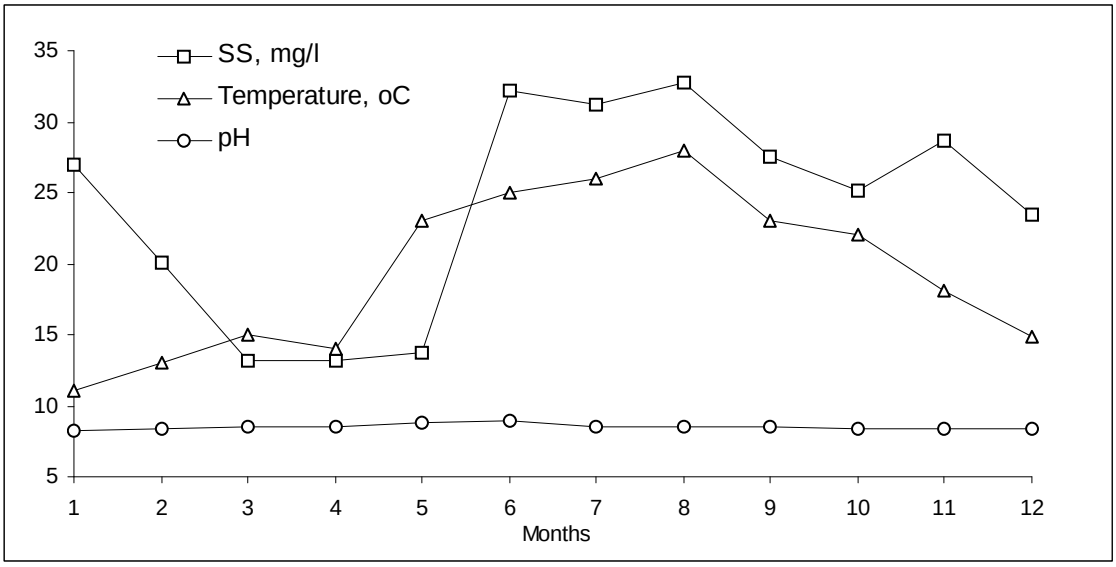

Figure 3. Seasonal variation of some quality parameters (1999)

4. RESULTS

In this study the water quality of Atatürk Dam Lake is established according to the samples, which are taken in each month of 1996, 1997, 1998 and 1999. Seasonal variations of the water quality were evaluated for some physical, chemical and microbiological parameters for the year of 1999.

According to the physical and inorganic properties of the water, the lake has high quality water generally. However, total coliform data of 1999 is quite high and indicate an important amount of domestic wastewater discharge.

From the eutrophication view, the water quality is low and the quality parameters are commonly higher than the limits. Total nitrogen and phosphorus have high values and

indicate an increasing trend for the years. The input of these parameters must be controlled for the protection of the trophic level of the lake.

Irrigational quality of the water is high except for electrical conductivity, suspended solids and fecal coliform values. Water class of the lake is determined as C2S1 meaning that the water can easily be used in irrigation of agricultural areas. Because the electrical conductivity is not in the first class, the large amounts of water mustn't be used due to the probable desertification problem in soil.

NH_3 and coliform bacteria, important problems for both human health, irrigation, are faced in the water of the lake, especially in hot months. Thus, untreated wastewater discharge into the lake must be controlled from the view of bacteriological pollution.

5. REFERENCES

Gerger, R., Yeşilnacar, İ, Yazgan, M. (1997) Potential of agricultural areas in the catchment area of Atatürk Dam and estimated agricultural pollution after the irrigation, *Proceedings of Water and Environment Symposium*, June 1997, İstanbul (in Turkish).

Topkaya, B., (1994) Multi-purpose use of Keban Dam Lake and the environmental problems", *Proceedings of the Protection of Water and Soil Sources of Turkey*, Volume 3, 1243-1255 (in Turkish).

Volkan, F., (1990) *Presentation of Southeastern Anatolian Project*, Publication of Turkish Water Administration, Ankara (in Turkish).

Yazgan, M.S., (1999) An investigation of existing water quality of Atatürk Dam Lake, Turkey, *Proceedings of 7th International Conference for the Israel Society for Ecology and Environmental Quality Sciences on Environmental Challenges for the Next Millennium*, June 13-18, 1999, Jerusalem, Israel.

Yazgan, M.S., Kınacı, C., (1997) Agricultural pollution risk in the dam lakes of Southeastern Anatolian Project, *Proceedings of Sea-Environment-Energy Symposium*, June 30 – July 4, 1997, Karamürsel, Kocaeli (in Turkish).

Yazgan, M.S., Kınacı, C., (1999) One of estimated and encountered environmental problems of Southeastern Anatolian Project (GAP): Disposal of drainage water, *Proceedings of 7th International Conference for the Israel Society for Ecology and Environmental Quality Sciences on Environmental Challenges for the Next Millennium*, June 13-18, 1999, Jerusalem, Israel.