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The Evaluation of Some Water Quality Properties of Atatürk Reservoir for Fish Culture

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Abstract: In this research, in order to determine some physical and chemical properties of Atatürk reservoir, water samples were analyzed montly. Surface water temperature changed from 8 to 25ºC. In terms of transparency, maximum Secchi- disc value was determined as 250 cm in November 1995, and minimum value was recorded as 50 cm in August 1996. Considering all chemical and physical data, it is found that the Atatürk reservoir's water was suitable for culture of Cyprinid species, especially for mirror carp.

Key words: Ataturk Reservoir, fish culture, cyprinidae

Atatürk Göletinin Bazı Su Kalite Özelliklerinin Kültür Balıkçılığı Bakımından Değerlendirilmesi

Özet: Araştırmada Atatürk göletinden su numuneleri alınarak suyun bazı fiziksel ve kimyasal parametreleri mevsimlere göre incelenmiştir. Yüzey su sıcaklığı 8-25ºC arasında değişmiştir. Berraklık yönünden yapılan Secchi disk ölçümlerinde maksimum değer Kasım 1995'da 250 cm ve minimum değer ise Ağustos 1996'da 50 cm olarak tespit edilmiştir. Elde edilen kimyasal ve fiziksel değerler dikkate alınarak yapılan değerlendirmede, gölette sazan türlerinin başarıyla yetiştirilebileceği sonucuna varılmıştır.

Anahtar kelimeler: Atatürk Göleti, kültür balıkçılığı, sazangiller

Introduction

Freshwater fish culture is a rapidly improving sector in Turkey (Alpbaz and Hoşsucu, 1996) especially in Eastern Anatolia. There were about 35 fish farms 285 tons/year capacities in Erzurum (Anonymous, 1997).

It is obvious that the more population increase, the more nutritional problems will occur, however the size of the available lands for aquaculture will not change (Sarıhan and Tekelioğlu, 1990). Therefore, in order to meet nutritional requirements of people and some other farmed animals, new water sources should be taken place (Timur, 1991; Yaramaz, 1992).

Sea fish culture has already caught a point in Turkey's economy (Alpbaz and Hoşsucu, 1996). To realize the same thing in freshwater fish culture, physical and chemical properties of Turkey's existing water sources should be investigated and evaluated for the fish culture. By this way, it will be possible to use water sources economically and get maximum profits (Timur, 1991; Yaramaz, 1992). Lakes, reservoirs and running waters aimed to use in fish culture should be having some certain properties in order to meet some environmental requirements such as temperature and dissolved oxygen of cold water or warm water fishes. Since fishes need different requirements in their growing stages, the properties of production media should be investigated for at least four season in a year (Timur, 1991; Yaramaz, 1992). Probably one of the most important things which is not usually taken into consideration by most of the fish producers is monitoring water every time to prevent possible problems such as pollution. However most of the beginners to fish culture are having their production water analyzed only once, at the beginning of the culture. If it is eligible for fish culture, then they usually do not care rest of the year and do not make their water analyzed again and give their own decision by the way. Starting like that to the fish culture cause some problems in further production stages or even big losses (Karaçam et al., 1994).

Three sources of water are available to fish farmers. Spring water or ground water are the sources that often seem to be the most desirable because of the constant temperature they provide. A second source is lake water, which gives several good options if the lake is large and deep, but such sites are rare. The third is surface water (stream etc.), the most abundant, but generally considered the least because weather conditions have such a strong influence on quality (Stickney, 1991).

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Fish producers have only two choices in producing fish in East Anatolia. Available fish species for culture are salmonids, especially rainbow trout and cyprinids, especially mirror carp. Of course the nutritional and environmental requirement of this fishes are quite different from each other. For instance, rainbow trout requires 14-18^{o}C water temperature, <8 pH, < 0.5 ppm NH_4, > 6 ppm dissolved oxygen and 2 m depth to be raised up in cage culture (Steffens and Menzel, 1976). In terms of cyprinid culture, for common carp optimum water temperature, dissolved oxygen and pH should be 23 ºC, 5 - 7 mg/l and 5.5-9 respectively (Alpbaz and Hoşsucu, 1989; Aras et al., 1995).

In fish culture, the most important inputs are oxygen, temperature and water supply (Sarıhan, 1976). Among the potentially damaging aspects of water supply may be extreme pH, ammonnia and suspended solids (Alabaster and Lloyd, 1980).

Not only EIFAC's tentative water quality standarts for suspended solids but also EEC Directive indicate that good salmonid fisheries are more likely to occur in the wild if the concentration of suspended solids is less than or equal to 25 mg/l (Alabaster, 1982).

Some researches have been realized by (Kolat, 1977; Obalı, 1978; Gündüz, 1981; Altuner, 1982; Hasselrot et al., 1984; Hultberg and Nyström, 1988; Kraiem and Pattee, 1988; Naslund, 1993; Şen and Toprak, 1996) in different water sources. Although some researches have been carried out in the past from the Erzurum's fresh water sources by authorities above, there was no data reported from the Atatürk Reservoir. Therefore, we thought that it might worth to carry out this investigation.

In this paper findings of this study and standard values from European Inland Fisheries Advisory Commission (EIFAC) for salmonid fish reported by Alabaster (1982) will be compared to each other and a final suggestion will be made for the fish farmers.

Material and Methods

The chemical and physical properties of the Atatürk reservoir water were investigated monthly basis and evaluated seasonally in 1996. The Atatürk Reservoir is 70 km from Erzurum and 10 km from Köprüköy, a province in Erzurum city (Fig. 1). The weather is very cold in winter and very hot and dry in summer in Erzurum. Climate was the same with the Erzurum in the research area. Some geological traits of reservoir are given in Table 1. There were a snow coverage about 5 months in the area. The average thickness of the snow is approximately 60 cm dependent upon years (Anonymous, 1995).

Table 1. Geological properties of the Atatürk Reservoir (Anonymous 1979a)

Volume (m^3)	1969310000
Dead volume (m^3)	85650000
Evaporation losses (m^3/year)	1413510.84
Leakage losses (m^3)	98465500
Available water volume (m^3)	1643843416
Maximum water depth (m)	13.50
Water mirror area (da)	335
Reservoir basin area (km^2)	4
Reservoir basin water yield (m^3/year)	507200000

Average precipitation values and evaporation losses from 1990 to 1995 were recorded as 29.40 ± 15.38 mm and 5.88 ± 1.18 mm (Anonymous, 1995).

Main purpose of the construction of the Atatürk reservoir was the irrigation (Anonymous, 1995). The reservoir's water supply came mainly from two sources. They were precipitation (snow fall in the winter - rain fall in spring, Autumn and summer), flowing water from a small brook namely Badicivan brook in Spring and Autumn not in Summer which comes from Badicivan - a small village in the area (Anonymous, 1995).

Water losses from reservoir were mainly from irrigation water June - August (no data available about its quantity), evaporation losses and leakage losses (Anonymous, 1979a; Anonymous, 1995).

Research was started December 1995 and ended November 1996, in winter months sampling could not been realized because of the ice cover. Therefore water quality parameters were investigated in only nine months (three season).

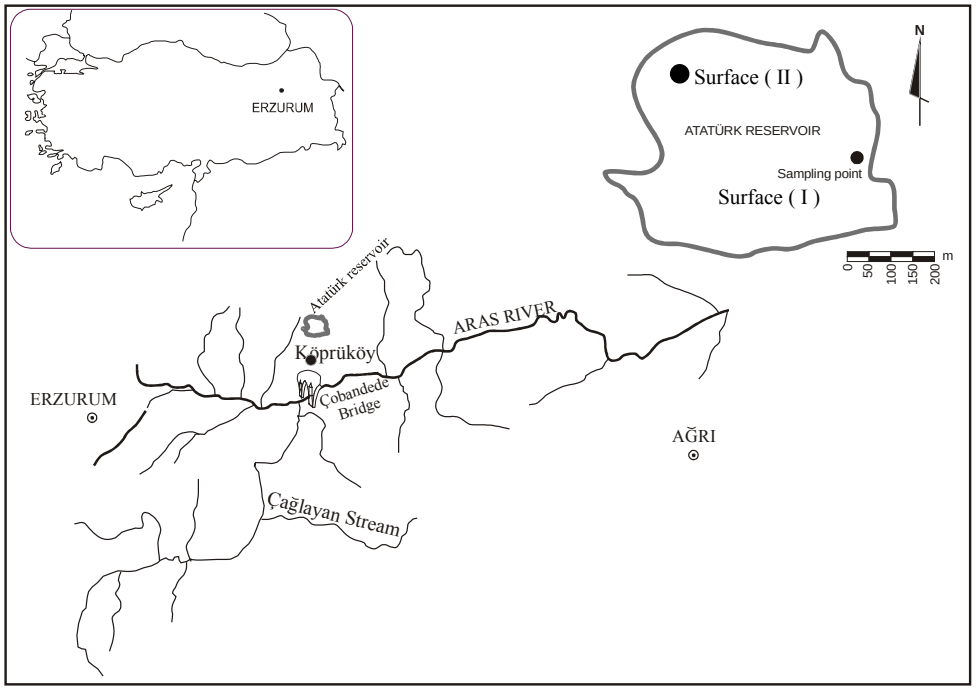

Figure 1. Location of the Atatürk Reservoir and sampling points.

Two sampling points were chosen to collect water samples as Surface I and surface II (Figure 1). Water samples were collected from 10 cm below water surface (absolute surface) and from 2 meters depth from Atatürk reservoir on monthly basis (Sarıhan, 1976; Boyd, 1980), and were evaluated seasonally.

To determine water temperatures and transparency, a mercury thermometer with 1°C sensitivity and a Secchi-disc were used in order (Sarıhan, 1976; Yaramaz, 1992; Akyurt, 1993).

Standard dark colored bottles were used to bring water samples to the laboratory (Boyd, 1980). The water samples were preserved in ice prior to analyzes (maximum 24 hours) (Stickney, 1993).

Chemical analyses and suspended solids of the water samples were done in the Agricultural Research and Extension Center of Erzurum by methods described in (Yaramaz, 1992; Akyurt, 1993).

Dissolved oxygen (DO) and pH values were determined in the field immediately after taking samples using an oxygen meter with 0.01 sensitivity and pH meter in order (Yaramaz, 1992; Akyurt, 1993).

Statistical analyzes were done by SAS program (Hellwig, 1981).

Results and Discussion

Differences in determined water temperatures and all of the other properties between absolute surfaces and 2 meters depths were not statistically significant. Therefore, only values determined from Surfaces I and II were used in evaluating reservoir's water in terms of fish culture. Results from chemical analyze and some physical properties of water were summarized in Table 2 from the Atatürk resorvior in 1996. With comparison to the standards and (Stickney, 1991), looking at the data presented in Table 2, it can be seen that the water was not completely suitable for salmonid culture especially in Summer period due to the high water temperature (Fig. 3).

EIFAC considered that during the warmest seasons 20-21 ^{o}C should be accepted as the maximum temperature for salmon and trout waters. The EEC Directive includes a mandatory maximum of 21.5 ^{o}C with a maximum of 10 ^{o}C during the salmonid spawning season (Alabaster, 1982), where temperature are not lower than 5 ^{o}C and pH values not higher than 8.0. EIFAC recommended a maximum concentration of 0.025 mg/l as undissociated ammonnia in salmonid waters. The EEC also chose this level as the mandatory maximum, and suggested a guideline level of 0.005 mg/l (Alabaster, 1982). Water temperature changed from 8.5-25°C with an annual aveage of 17.17 ± 5.91°C (Table 2). However, in comparison to the standarts, if montly evaluation made, it can be seen that water was not suitable for salmonid culture but for cyprinid culture in the months of June, July, August and September (Table 2, Figure 3) from water samples. The differences between measured values from two sampling points were not statistically significant in terms of all data except transparency ($p<0.01$). Water limpidness Secchi - disc measurements were presented in (Table 2, Fig. 4).

Because of the using water of reservoir to irrigate farmland, water level in reservoir decreased in summer months. Reducing water level and increasing environmental temperature caused an increase in water temperature in Summer and early Autumn (Table 2).

The water quality standart for dissolved oxygen tentatively proposed by EIFAC for salmonid waters was an annual median of 9 mg/l. As a rough guide, this means that if 20 samples were taken in a year ten should have a DO of at least 9 mg/l but one could be "permitted" with a DO as low as 5 mg/l. According to European Communities (Anonymous, 1979b) in its freshwater fish directive", as a guideline, that all samples should equal or exceed 7 mg/l in salmonid waters (Alabaster, 1982).

DO values from sampling points based on months and seasons are presented in Table 2 and Fig 2. From the point of DO values view, water was suitable for the salmonid and cyprinid culture, although annual average values were below the optimum requirement in the months of June, July, August and September for salmonid culture when comparing the data to EIFAC's standard values. DO reduced with the increasing water temperature (Table 2). Average maximum and minimum dissolved oxygen values were determined as 6.10 ppm in August and 8.85 ppm in April with an annual average of 7.32 ± 0.91 ppm (Table 2)

Since, there were ice cover in winter months; the reservoir is not suitable for fish culture in that season.

Secchi disc value was minimum (50 cm) during the summer (in August), and became maximum (250 cm) in Autumn (in November) (Table 2, Figure 4). Average annual Secchi - disc value was 84.44 ± 20.83 cm from surface I and 148.89 ± 59.04 cm from surface II with an average of 116.67 ± 38.69 cm. As a result, in terms of Secchi - disc values, considering the determined data, it might be inferred that the water may be accepted as suitable for cyprinid culture in all investigated months.

pH values of water samples were determined and presented in Table 2 based on months. Average pH value changed from 7.32 - 8.64 with an annual average of 7.97 ± 0.52. This value was falling in the standards range reported by EIFAC and (Stickney, 1991). Hovewer, there were excess in pH values in the months May, July from surface I and in May, June from Surface II. The differences between pH values from months were not statistically significant. Therefore, it can be suggested that fish culture in this reservoir can be realized safely in terms of average pH.

Suspended solid values were higher than the EIFAC's standard values (Table 2). Average suspended solids changed from 24.50 mg /l in June and 46.50 mg/l in August with an 31.39 ± 8.97 mg/l. Hovewer, this value was in accordance to the data reported by (Stickney, 1991). Therefore, we can say that water was suitable for the salmonid fish culture.

Hardness values based on 10 mg $CaCO_3$ were also determined and presented in Table 2. There were no statistically differences in terms of water hardness. Hardness values changed from 14.6 - 28 from surface I to 16 - 30 from surface II. Average annual hardness values were 21.51 ± 5.14 from surface I and 22.44 ± 4.85 from surface II with a grand average of 21.98 ± 4.97. These values fell to the data range reported by (Aras et al., 1995). Therefore, it can be said that the water was suitable for salmonid fish culture in terms of hardness.

Calcium and magnesium values were determined and presented in Table 2. The values fit the data range reported by (Aras et al., 1995). And the differences between the calcium values based on months and magnesium values based on months were not statistically significant. Average calcium values were higher than the magnesium values (Table 2).

All of the data determined from the present study were compared to the criteria given by Alpbaz and Hoşsucu, (1989), Çelikkale, (1991) and Aras et al., (1995). According to this comparison, it can be say that the water of Atatürk Reservoir was not suitable for salmonids but cyprinids especially for mirror carp culture.

As a consequent, from the all data determined in this research point of view, It can be concluded that salmonid culture especially rainbow trout can be raised in cages from Spring to mid Summer. On the other hand, cyprinids especially mirror carp can be raised either extensively or intensively in cages in the Atatürk Reservoir in all of the year except winter months. Therefore, fish farmers should plan integrated rearing methods for the throughout the year.

Table 2. Water quality parameters from Atatürk reservoir based on months[(1)]

Months	DO (mg/l)	pH	Temp. (^{o}C)	Hardness (10 mg/l $CaCO_3$)	Secchi -Disc (cm)	Ca^{++} (mg/l)	Mg^{++} (mg/l)	Suspended solids (mg/l)
				Surface I*				
Mar. 96	7.80	7.60	8.00	14.60	85.00	48.70	25.74	30.00
Apr.	8.70	7.52	12.00	24.00	75.00	69.80	26.80	42.00
May	7.50	8.68	18.00	28.00	90.00	59.87	27.76	45.00
June	6.50	8.40	22.00	22.00	65.00	32.15	15.00	26.00
July	6.20	8.76	24.00	25.00	75.00	32.50	13.00	29.00
Aug.	6.00	7.85	26.00	15.00	50.00	80.65	30.64	52.00
Sep.	6.60	8.20	21.00	27.00	95.00	76.45	38.80	32.00
Oct.	7.80	7.65	17.00	22.00	110.00	82.52	39.72	30.00
Nov.	7.40	7.43	10.00	16.00	115.00	96.00	42.15	22.00
An. Ave.	7.17	8.01	17.56	21.51	84.44	64.29	28.85	34.22
Stdv (±)	0.89	0.51	6.37	5.14	20.83	22.61	10.34	9.86
				Surface II**				
Mar.96	8.70	7.20	9.00	16.00	120.00	36.45	24.12	25.00
Apr.	9.00	7.60	11.00	23.00	105.00	54.20	22.60	36.00
May	7.60	8.60	17.00	30.00	100.00	43.10	30.41	38.00
June	6.80	8.80	20.00	24.00	115.00	26.80	18.47	23.00
July	6.50	8.20	23.00	25.00	125.00	30.00	18.60	25.00
Aug.	6.20	8.30	24.00	17.00	100.00	82.00	40.52	41.00
Sep.	7.00	7.90	20.00	27.00	200.00	78.00	32.00	29.00
Oct.	7.80	7.50	16.00	23.00	225.00	65.00	36.00	24.00
Nov.	7.60	7.20	11.00	17.00	250.00	78.00	44.00	16.00
An. Ave.	7.47	7.92	16.78	22.44	148.89	54.84	29.64	28.56
Stdv(±)	0.95	0.59	5.47	4.85	59.04	21.78	9.34	8.17
				Average				
Mar.96	8.25	7.40	8.50	15.30	102.50	42.58	24.93	27.50
Apr.	8.85	7.56	11.50	23.50	90.00	62.00	24.70	39.00
May	7.55	8.64	17.50	29.00	95.00	51.49	29.09	41.50
June	6.65	8.60	21.00	23.00	90.00	29.48	16.74	24.50
July	6.35	8.48	23.50	25.00	100.00	31.25	15.80	27.00
Aug.	6.10	8.08	25.00	16.00	75.00	81.33	35.58	46.50
Sep.	6.80	8.05	20.50	27.00	147.50	77.23	35.40	30.50
Oct.	7.80	7.58	16.50	22.50	167.50	73.76	37.86	27.00
Nov.	7.50	7.32	10.50	16.50	182.50	87.00	43.08	19.00
An. Ave.	7.32	7.97	17.17	21.98	116.67	59.57	29.24	31.39
Stdv (±)	0.91	0.52	5.91	4.97	38.69	21.81	9.49	8.97

(1) Water samples could not provided for winter months.
* Maximum water depth was 230 cm
** Maximum water depth was 400 cm

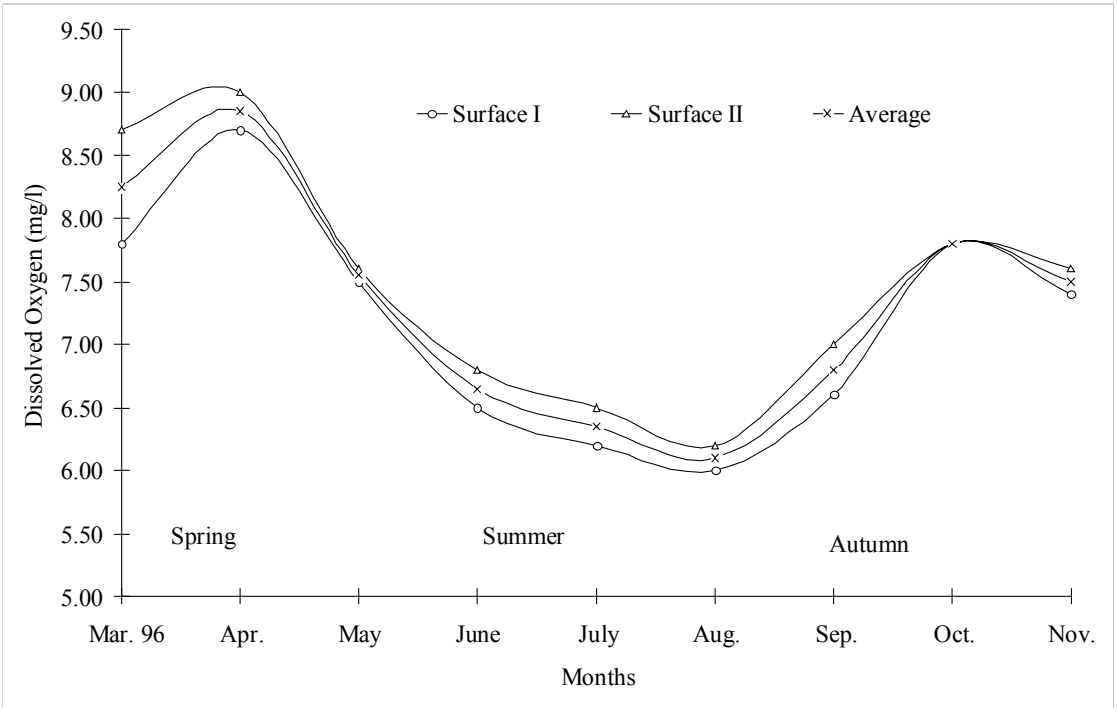

Figure 2. Changes in dissolved oxygen (ppm) concentrations in Atatürk reservoir.

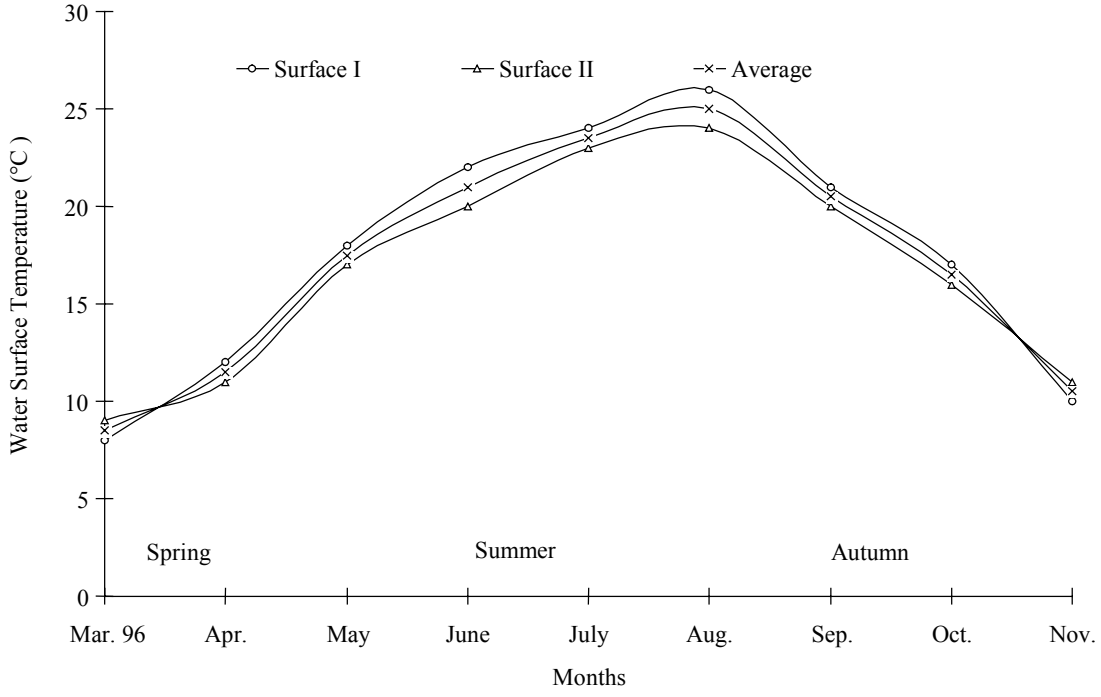

Figure 3. Changes in water temperature in Atatürk reservoir.

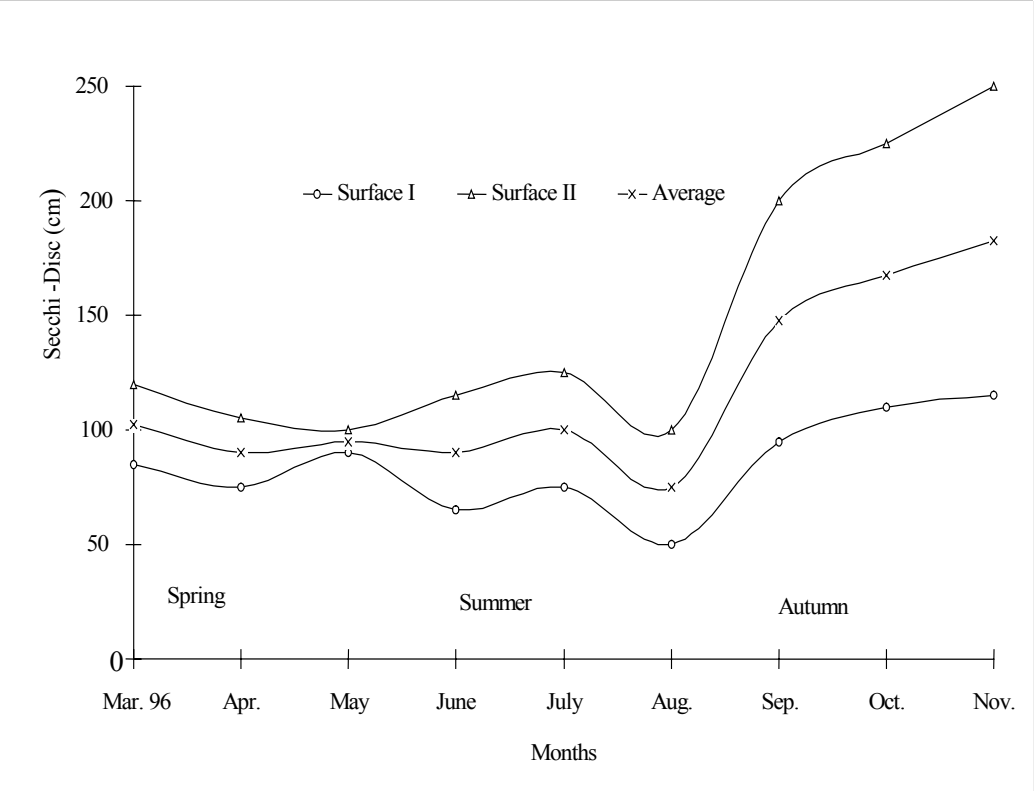

Figure 4. Changes in Secchi -disc values in Atatürk reservoir.

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