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An Investigation For The Determination Of Some Pollution And Quality Parameters In Some Springs Of Rivers In Gölcük Environs, Turkey*

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ABSTRACT : While the need of water supply is increasing, the suitable water springs are polluted by various usage and thus water treatment is restricted.The problem in water supply around Gölcük and surrounding villages will increase in the future. We could not find any data on the degree of pollution or purity of these springs. For that reason we decided to determine the pollution and quality classification of the water springs around this area.The work was carried out in eight water springs in Gölcük and its surrounding villages. These eight water springs were selected arbitrarily and the samples were taken from these springs every month during a year for analysis of the physical, inorganic and organic parameters. BOD_5, COD, NO_2-N, NO_3-N, NH_4-N and SO_4^{-2} were analysed and pH measurements were carried out.According to results of analysis; the avarage values of the samples for 13 months fluctuate between pH 6.0-7.2. The value of BOD_5 fluctuates between 5.3 mg L^{-1} and 3.8 mg L^{-1}. COD varies between 6.6 mg L^{-1} and 4.5 mg L^{-1}. NO_2-N is obtained as 0.015 mg L^{-1} in water resources. The value of NO_3-N fluctuates between 0.22 mg L^{-1} and 0 38 mg L^{-1} . NH_4-N is determined as < 2 mg L^{-1} for all water sources. SO_4^{-2} is determined as < 40 mg L^{-1}. The temperature of the water springs was measured and the colour and the turbidity were observed at the sampling points in comparision with the laboratory work. All the parameters obtained were interpreted according to inter-continental water springs classification and the changes in the parameter values were determined depending on time, season, rain and environment.As a result, the annual change of the water samples analysed were determined.All the water springs were discussed for the point of view of the suitability of drinking. treatment and watering and their class of water quality were figured out.

Key Words: Water pollution, Water quality, Spring water, BOD_5, COD

Gölcük Çevresinde Bazı Akarsu Kaynaklarında Kirlilik ve Kalite Sınıflarının Belirlenmesi Üzerine Bir Araştırma

ÖZET: Suya olan gereksinim artarken, çeşitli kullanımlarla uygun kalitedeki su kaynakları kirletilmekte hu da su kaynaklarının çeşitli amaçlar için kullanımını kısıtlamaktadır.Gölcük ve çevresindeki köylerde de su gereksinmesinin sağlanmasındaki sorunlar gelecekte de artacaktır. Akarsu kaynaklarında kirlilik ve kalite sınıfının belirlenmesine ait herhangi bir çalışma bulunmamıştır. Bu nedenle bu yöreye ait bazı akarsu kaynaklarında kirlilik ve kalite sınıflarının belirlenmesine karar verilmiştir.Araştırma Gölcük İlçesi ve civar köylerinde 8 akarsu kaynağında yürütülmüştür. Bu 8 akarsu kaynağı tesadüfi olarak seçilmiş ve bu su kaynaklarından bir yıl boyunca her ay örnek alınarak bazı fiziksel, inorganik ve organik parametrelerin analizleri yapılmıştır. Örneklemelerde $BOİ_5$, KOİ, NO_2-N, NO_3-N, NH_4-N ve SO_4^{-2} parametrelerinin analizi yapılmış ve pH ölçülmüştür. Analiz sonuçlarına göre; pH 6.0-7.2, BOD_5 5.3-3.8 mg L^{-1}, arasında bulunmuştur. COD 6.6-4.5 mg L^{-1} arasında değişmiştir. NO_2-N 0.015 mg L^{-1} saptanmıştır. NO_3-N 0.22-0.38 arasında değişmiş, NH_4-N < 2 mg L^{-1} ve SO_4^{-2} < 40 mg L^{-1} bulunmuştur. Örnekleme noktalarında akarsu kaynaklarının sıcaklıkları ölçülmüş, gözlemle renk ve bulanıklık saptanmış ve laboratuvar çalışmasıyla karşılaştırılmıştır. Analizi yapılan tüm parametreler kıta içi su kaynakları sınıflarına göre değerlendirilmiş ve parametre değerlerinin zaman, mevsim, yağış ve çevreye bağlı olarak değişimleri saptanmıştır.Sonuç olarak; örnekleme yapılan su kaynaklarında analizi yapılan parametrelerin yıllık değişimleri grafiklerle belirlenmiştir. Tüm su kaynakları içme, kullanma ve sulama suyu uygunluğu açısından tartışılarak kaynakların su kalite sınıfları ortaya konmuştur.

Anahtar Sözcükler: Su kirliliği, Su kalitesi, Akarsu, $BOİ_5$, KOİ

INTRODUCTION

The rapidity of economic development cause important in water supply in Turkey. The avarage rate of population increase was 2.17 % in 1990. This rate was 4.7 % for the cities. The daily personal water consuming rate increases the rate of drinking, treatment and supply very seriously. DSİ (Water Treatment of Goverment) data indicate 34 % increase in the water demand from 1990 to 2000.

The quality measurement related to the natural spring water resources and the determination of the water quality classification are focused in the western part of Turkey where the population and the industry are very high. However, the narrow time interval of the measurements and the quality of the measured parameters are insufficient for a comprehensive survey.

Standard measurements of thirty parameters are used in determining the water quality classification. The suitability of the water according to its usage is interpreted after analysing these parameters.

Biological Oxygen Demand (BOD_5) observed over a five day period on the same body of water by measuring oxygen consumption indicates the amount of organic material and bacteria present (Kaplan and Sönmez, 2000).

Chemical Oxygen Demand (COD) is the measure of the chemical and biochemical oxidisable materials in water. This parameter is frequently used to determine the

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amount of organic and inorganic materials present due to household and industrial pollution (Kaplan and Sönmez, 2000).

Wolff (2001), Law 48 which concerns the protection of the Nile river and the Egyptian waterways from pollution only allows drain water with BOD_5 concentrations lower than 10 mg L^{-1} and COD lower than 15 mg L^{-1} and oxygen higher or equal to 5 mg L^{-1} to be lifted up and mixed with water in irrigation canals for reuse. As mentioned above, some areas of the Nile Delta region are especially affected by increasingly deteriorating water quality.

The transformation of the nitrite (NO_2- N) compounds occurs from amonnia step by step. For that reason, the existence of NO_2 in water indicates the existence of excretia in water. Fresh water must not contain NO_2.

Nitrate (NO_3-N) is the end product of oxidised nitrogen mineralization. The presence of nitrate in the water is due to pesticide application, waste water and from agricultural fields and the cupper content of the soil. The tolerable limit in fresh and used water is 45 mg L^{-1} (Tok, 1997).

Ammonium (NH_4-N) is formed from the bacterial respiration of sewage. The limit value is 0.5 mg L^{-1} if the ammonium content in water is because of geological reasons.

Conides and Zacharaki (2001), the nitrogen nitrites were found low in all statitions (0.02-0.08 mg L^{-1}) except the station located in Evros river (in Greece) during winter (0.18-0.28 mg L^{-1}). Total ammonia was found high in Evros river (1.5-2.6 mg L^{-1}) and rather low (0.2-0.8 mg L^{-1}) in the other stations. These levels are considered acceptable for the survival of most aquatic organisms (Pillay, 1992; Koussouris et al., 1995). The nitrogen nitrates fluctuate between 2 mg L^{-1} and 8 mg L^{-1} but are high in Evros river during fall (12-20 mg L^{-1}).

Delibacak et all., (2002), water samples were analysed in terms of NH_4-N, NO_2-N and NO_3-N in the Gediz river (in Turkey). According to result of analysis, NH_4-N is 0.231 mg L^{-1}, NO_2-N is 0.136 mg L^{-1} and NO_3-N is 0.346 mg L^{-1} respectively as average.

Sulfate (SO_4^{-2}) occurs in the formation of gypsum and anhidrate. The limit level in fresh and used water is 200-240 mg L^{-1} (Tok, 1997).

The pH value does not affect the health directly. The parameters that increase or decrease the value of SO_4^{-2} can be harmful. A pH value of 6.5-8.5 is recommended for fresh water (Dökmen, Kurtuluş and Endeş, 2000).

In this work, some physical and chemical parameters of the spring water resources around the Kocaeli-Gölcük area were determined to figure out their pollution status and also to find their quality classification.

MATERIALS AND METHODS

Gölcük is a town of Kocaeli in the Marmara Region. The soil of the town lies in a narrow plain along the Marmara Sea and in a rocky area behind the plain.

The investigation was carried out at eight surface water resources in Gölcük town and its surrounding villages. This work was conducted between December 1996-1997. In this work pH, BOD_5, COD, NO_2-N, NO_3-N, NH_4-N and SO_4^{-2} parameters were examined. The names, places and characteristics of the water sources are shown in Table 1 (Anonymous,1996).

The standard sampling methods (APHA,1985) were used in the work, and the samples were analysed according to standard methods.

Table 1. The water sources and the characteristics of their location

Spring No.	Village	Locating of the Sprlug	Flow (Ls^{-1})	Soil Characteristic	Land Structure	Plant Cover
1	Ümmiye	Şelale	0.5	Sandy	Fertile plain	Forest
2	Mamuriye	Altınoluk	1.0	Sandy loam	Fertile plain	Forest
3	Ferhadiye	Çürükhayır	0.5	Clay loam	Sloping land	Forest
4	Nüzhetiye	Karanlıkdere	0.3	Loam	Sloping land	Forest
5	Nüzhetiye	Değirmendere	0.9	Loamy sand	Sloping land	Forest
6	Nüzhetiye	Sakarbıçkı 1	0.5	Sandy loam	Sloping land	Forest
7	Nüzhetiye	Sakarbıçkı 2	0.5	Clay loam	Sloping land	Forest
8	Yeniköy	Havuzluhahçe	0.9	Clay loam	Fertile plain	Field

RESULTS AND DISCUSSION

The 13 month avarage values of the quantities of pH, BOD_5, COD, NO_2-N, NO_3-N, NH_4-N and SO_4^{-2} in the samples taken from 8 different surface water sources in the area under investigation, and its surrounding villages, are given in Table 2.

As seen from Table 2, the avarage values of the samples for 13 months fluctuate between pH 6.0-7.2. All the water sources beyond No: 3 satisfy the first class water quality for the pH. From the point of view of drinking water, the pH values of all the water sources except No:3 are in accordance with TSE 266 (pH 7.0-8.5).

The value of BOD_5 fluctuates between 5.3 mg L^{-1} (Number 6) and 3.8 mg L^{-1} (Numbers 2,3,4).According to inter-continental water spring classification, sources 2,3,4,5, 7 and 8 are of first quality of water (maximum limit 4 mg L^{-1}) and sources 1 and 6 are of second quality.

COD varies between 6.6 mg L^{-1} and 4.5 mg L^{-1}. According to classification, all the water sources are of first class (Anonymous,1992).

A value of 0.015 mg L^{-1} for NO_2-N is obtained in water resources. All of the water resources are of second quality since 0.002 mg L^{-1} is the maximum limit for first class water. The value of NO_2-N must be 0.0 mg L^{-1} in fresh water (Anonymous,1986).

The value of NO_3-N fluctuates between 0.22 mg L^{-1} and 0.38 mg L^{-1} in the eight water sources. Since the maximum limit of NO_3-N for first quality is 5 mg L^{-1}, all of the water sources are of first quality. The value of NO_3-N must be 0.0 mg L^{-1} in fresh water (Anonymous, 1986).

The value of NH_4-N is determined as < 2 mg L^{-1} for all water sources. According to classification, all the sources are of second quality. In fresh water, the limit value is 0.0 mg L^{-1}. For that reason, the sources under investigation are not suitable for this parameter.

The value of SO_4^{-2} is determined as < 40 mg L^{-1}. According to inter-continental water spring classification, since the value determined in this work is smaller than for first class quality water (maximum permissible value of 200 mg L^{-1}), all the water sources are of first quality for this parameter (Anonymous, 1986).

The change of concentration of every parameter examined in the research area for 8 different water sources are given in figures 1, 2, 3, 4, 5, 6 and 7 for a 13 month time period (December 1996-1997).

(See Figure 1): BOD_5 value fluctuates between 3 mg L^{-1} - 4.5 mg L^{-1} in all water sources except 6. In summer, BOD_5 decreases to 4 mg L^{-1} in source 6, while the others show values from 3 mg L^{-1} to 4.5 mg L^{-1}. In fall, after september, (as measured in 1997) this changes between 3.5 mg L^{-1} and 6 mg L^{-1}. Notably, water source 8 falls to 2 mg L^{-1}.

If we look at the change of COD concentration for the period of 13 months, we see that the value of COD has been constant as 15 mg L^{-1} for all water sources except 1, whose value of COD reached to 17 mg L^{-1} in June 1997. These values indicate that the amount of the chemical and biochemical oxidised material is very little (Figure 2).

The change of the value of NO_2-N has been constant at 0.015 mg L^{-1} for the time period of the 13 month (Figure 3).

As seen from Figure 4, the maximum change of NO_3-N occurs at water sources 8. This value is 0.55 mg L^{-1} in January, 0.45 mg L^{-1} in June and 0.65 mg L^{-1} in November. This value became 0.45 mg L^{-1} in April and 0.5 mg L^{-1} in October in 6. This value fluetuates between 0.2 mg L^{-1} and 0.45 mg L^{-1} in the other water sources.

The values of NH_4-N and SO_4^{-2} during the 13 month period are constant at 2 mg L^{-1} (NH_4-N) and 40 mg L^{-1} (SO_4^{-2}) (Figure 5 and 6).

The pH value fluctuates between 5-6 from November 1996 to March 1997, and reaches 7-8 in the spring. After May 1997, the pH value of all the water sources reaches to 8-8.5 in the winter. The acidic concentration of the water has increased due to the accumulation of organic and inorganic materials. In summer, since the amount of organic and inorganic materials mixed with the water decreases, the pH value of the water changes. This causes the pH value of the water sources to be more thau 7 (Figure 7).

Table 2. The 13 months' mean values of pH, BOD_5, COD, NO_2-N, NO_3-N, NH_4-N and SO_4^{-2} in the surface water resources (in mg/litre, other than pH)

Spring No.	Date	Parameters						
		pH	BOD_5	COD	NO_2-N	NO_3-N	NH_4-N	SO_4^{-2}
1	1996-97	7.2	4.7	6.1	0.015	0.29	<2	<40
2	1996-97	7.0	3.8	4.7	0.015	0.26	<2	<40
3	1996-97	6.0	3.8	4.5	0.015	0.26	<2	<40
4	1996-97	7.1	3.8	4.7	0.015	0.25	<2	<40
5	1996-97	7.1	4	4.8	0.015	0.22	<2	<40
6	1996-97	7.1	5.3	6.6	0.015	0.23	<2	<40
7	1996-97	7.2	4	4.8	0.015	0.27	<2	<40
8	1996-97	7.1	4	5.1	0.015	0.38	<2	<40

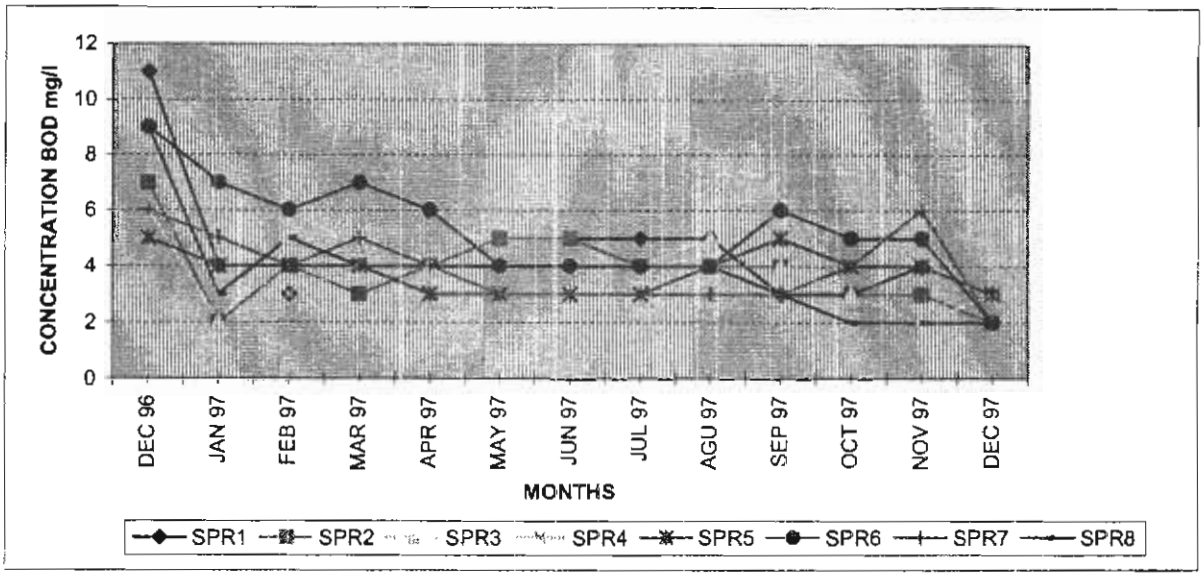

Figure 1. Amounts of BOD_5 in the water sources in Gölcük and surrounding villages during a 13 month period in 1996-1997

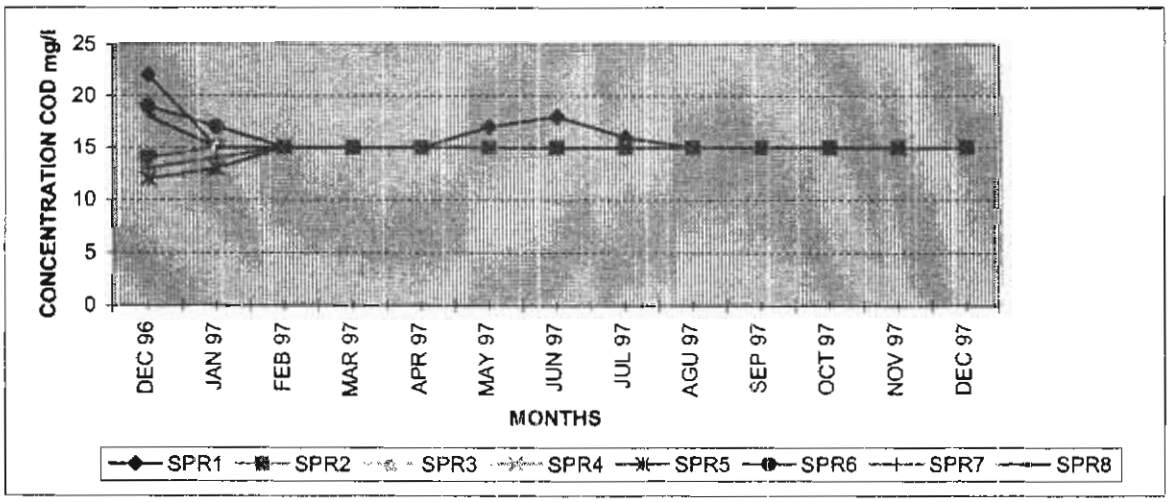

Figure 2. Amounts of COD in the water sources in Gölcük and surrounding villages during a 13 month period in 1996-1997

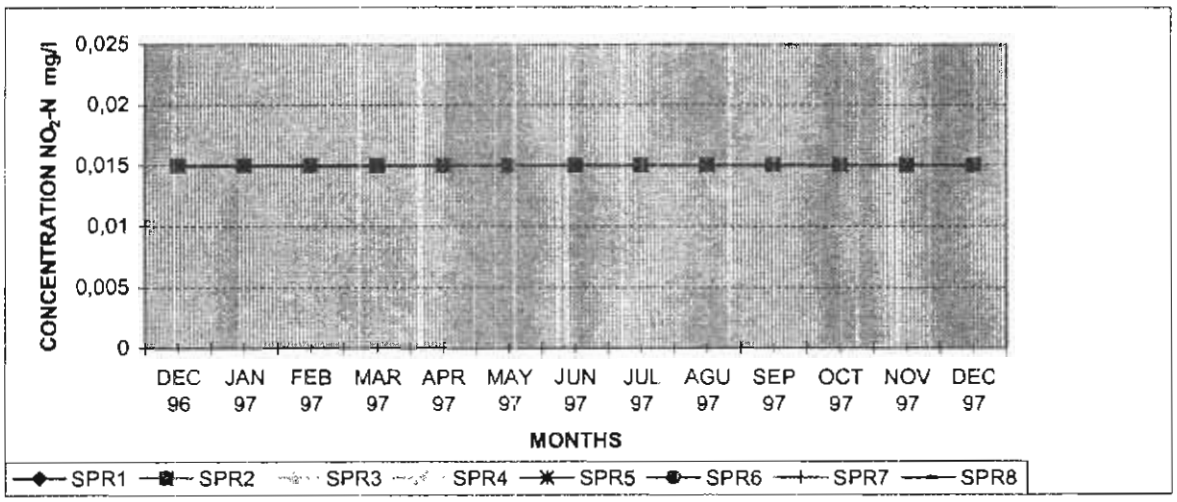

Figure 3. Amounts of NO_2-N in the water sources in Gölcük and surrounding villages during a 13 month period in 1996-1997.

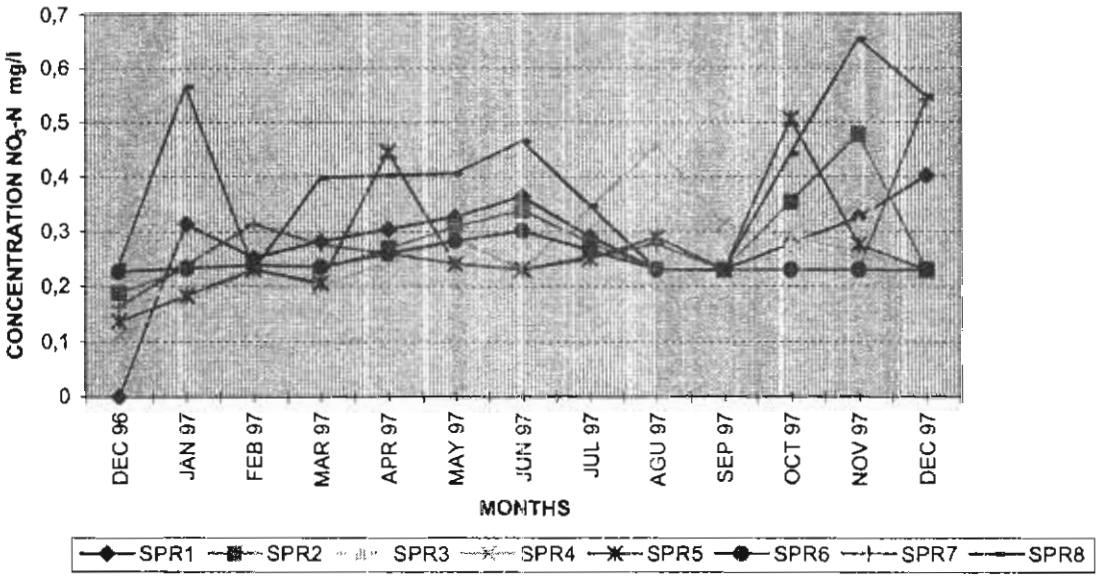

Figure 4. Amounts of NO_3-N in the water sources in Gölcük and surrounding villages during a 13 month period in 1996-1997

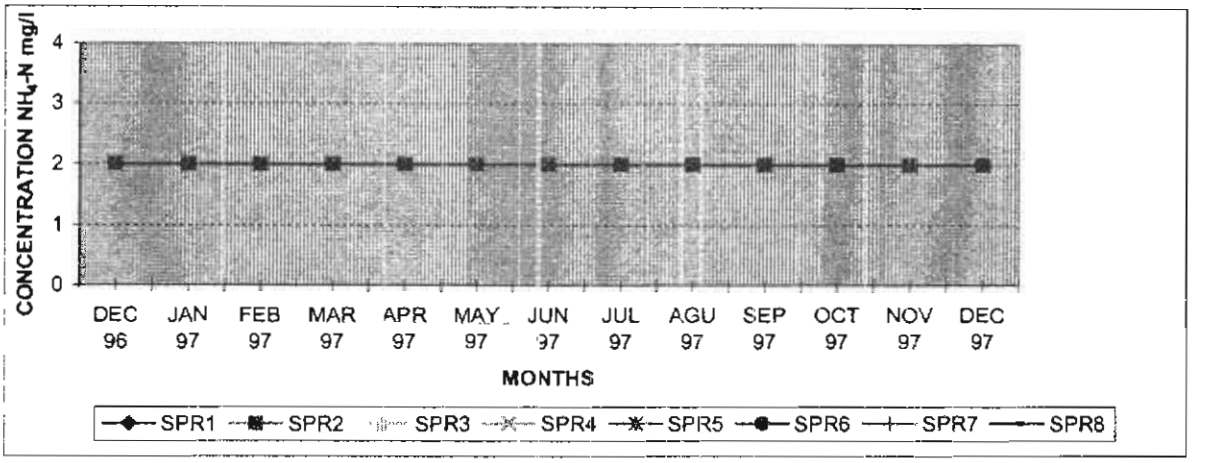

Figure 5. Amounts of NO_4-N in the water sources in Gölcük and surrounding villages during a 13 month period in 1996-1997

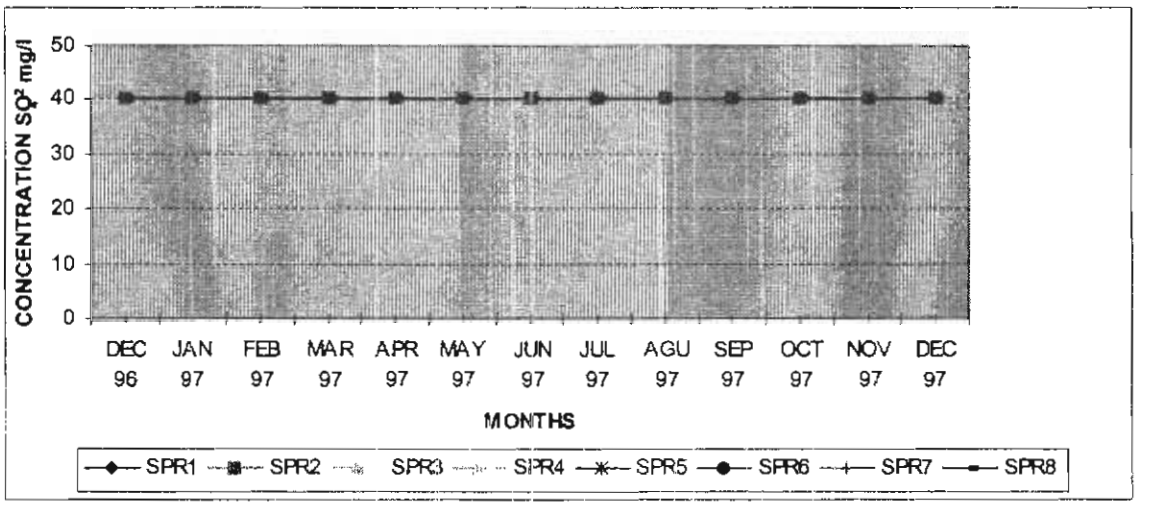

Figure 6. Amounts of SO_4^{-2} in the water sources in Gölcük and surrounding villages during a 13 month period in 1996-1997

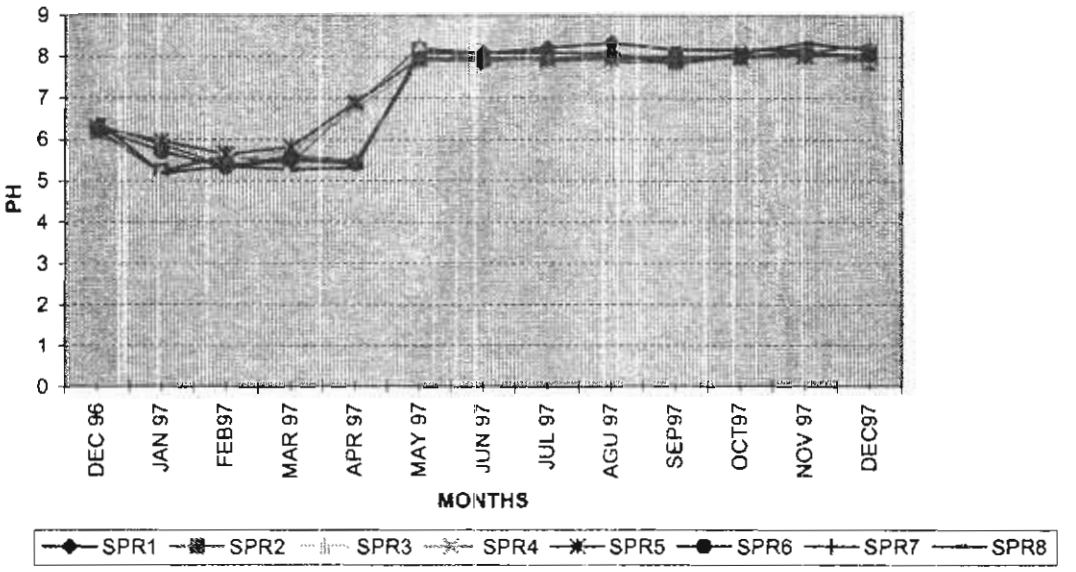

Figure 7 pH values from the water sources in Gölcük and surrounding villages during a 13 month period in 1996-1997

All of the water sources are not very clear in spring, fall and winter. They are yellowish and contain some deposits. The water is only a little clear in summer. There are no industry or habitations that pollute the water around the sources. These water sources are beyond any agricultural area but the land is forested.

CONCLUSION

The soil erosion which occurs in the rainy months plays an important role in the value of BOD_5 and COD. The smaller BOD_5 values indicate that the water is clear and the microorganisms do not exhaust the organic materials (Kaplan and Sönmez, 2000).

According to results above, the analysis values of the parameters of pH, COD, BOD_5 (except springs 1 and 6, which are of second quality), NO_3-N and SO_4^{-2} from all the water sources are acceptable as first quality. NO_2-N and NH_4-N levels are acceptable as second quality.

Although the spring water is clean, it faces a direct threat of pollution at every point. NO_3-N levels are low enough for first class category drinking water. This shows non-pollution due to agricultural waste. Analysis results show a very small, permissible maximum value of 45 mg L^{-1} for drinking and domestic usage water.

NO_2-N generally occurs as ammonia and organic nitrojen from bacteria in the water. For this reason, they are easily oxidised and are rarely present in significant concentrations in surface waters. If NO_2-N is present in the water, it is not shown as a from of pollution. According to the results,the concentration of NO_2-N is not very high and its value is of second class.

None of the springs under investigation shows especially significant sulphates (SO_4^{-2}) values. NH_4-N shows second class water levels; this means sewage (human or animal) is present in the water.

The analysis results were interpreted using Turkish Environmental Law (Anonymous, 1992), water pollution control statues intercontinental water sources classification and TSE 266 Drinking Water Standarts. According to these, first class quality water is drunk after being disinfected; second class quality water is drunk after filtering and third class quality water is used for cleaning after filtering. Fourth class quality water is categorised as over polluted and is not suitable for usage.

Generally speaking, general water quality monitoring is not carried out in a systematic way in Turkey. In future regionally or nationally attention must be given to natural source water quality in any sehemes concerning water exploitation. This kind of scheme can only be carried out effectively with recourse to accurate and systematic data. The local research carried out in Gölcük and environs, being a comprehensive study of surface water sources, their quality, their suitability for drinking, general usage and irrigation, may serve as an example of what should be done nationally and deserves the attention of all.

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