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Research Article

Investigation of Environmental Quality of Yuvacik Dam Basin Groundwater and Surface Water Resources

Erkan KALIPCI *[1], Selçuk VAROL [2], Hüseyin CÜCE [3]

[1]Giresun University, Department of Geomatics Engineering, Giresun, Turkey (*ORCID Number:* https://orcid.org/0000-0002-1908-5468)

[2]NEVÜ University, Department of Environmental Engineering, Nevsehir, Turkey (*ORCID Number:* https://orcid.org/0000-0002-0728-1162)

[3] Giresun University, Department of Geomatics Engineering, Giresun, Turkey (*ORCID Number:* https://orcid.org/0000-0002-3590-681X)

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Abstract

The purpose of this study was to characterize the drinking water resources of Kocaeli Province and classify them according to water quality. For this purpose, the raw water samples were collected and analyzed during the two seasons from the streams feeding Yuvacık Dam Lake, which meets about 90% of the drinking water requirement of Kocaeli Province, and ground sources of drinking water. The characterization of these sources, water quality classes of dam basin were determined by evaluating the analysis results. Considering the related regulations, in terms of pH, conductivity, chemical oxygen demand, dissolved oxygen, biological oxygen demand, ammonium nitrogen, nitrate nitrogen, orthophosphorus phosphorus, fluoride, total Kjeldahl-nitrogen, total phosphorus, manganese, and selenium parameters, drinking water resources are in the Class I (AA) water quality class.

Yuvacık Baraj Havzası Yeraltı Ve Yerüstü Su Kaynaklarının Çevre Kalitesinin Araştırılması

Anahtar Kelimeler
Yuvacık havzası
Yüzey ve yeraltı suları
Su kalitesi
Kocaeli

Özet

Bu çalışmada; Kocaeli ilindeki içme suyu kaynaklarının karakteristik özellikleri belirlenmiş olup su kaynaklarının kalite kategorilerinin tespiti yapılmıştır. Kocaeli ilinin su ihtiyacının yaklaşık % 90'ını karşılayan Yuvacık baraj gölünü besleyen dereler ile kaynak sularını temsilen belirlenen noktalardan iki dönem hamsu numuneleri alınmıştır. Yerüstü ve yeraltı su kaynaklarına ait analiz sonuçları ilgili yönetmeliklere göre değerlendirildiğinde; pH, elektriksel iletkenlik, kimyasal oksijen ihtiyacı, çözünmüş oksijen, biyolojik oksijen ihtiyacı, amonyum azotu, nitrat azotu, orto fosfat fosforu, florür, toplam kjeldahl-azotu, toplam fosfor, mangan ve selenyum parametreleri açısından I.Sınıf (çok iyi) su kalitesi özelliği gösterdiği belirlenmiştir.

INTRODUCTION

Today, determination of the quality of water resources and water quality management studies created accordingly occupy an important place among important researches all over the world. Studies on water quality are very important in determining the purpose of water use, as well as important for the sustainable use of surface water resources [1]. The annual amount of water available per person per year in Turkey in 2000 1.652 m^3, while in 2009 was 1,544 m^3 and 1,346 m^3 in 2020 has decreased. Turkey is among the countries experiencing water pressure when looking at the water potential available per capita. Therefore, it is important to use water efficiently and optimally [2]. And also; It should be ensured that the necessary measures are taken to determine the water quality, to determine the pollution elements and to minimize them [3]. In particular; Point and non-point pollutant sources around dams utilized as drinking and utility water should be taken under control [4]. Considering the current situation in terms of water pollution in Turkey; It is seen that the primary environmental problem of cities is water pollution and when the first priority environmental problems are compared by years, it is determined by the Provincial Directorates of Environment and Urbanization that there has been an increase in water pollution-related problems in the last five years [5]. In order to contribute to the development of solutions to these problems related to water pollution in our country in recent years, the increase in scientific studies conducted in the treatment of wastewater and water quality determination-monitoring studies are of great importance for our country's achievements.

In order to ensure the continuity of ecological balance and to benefit from water resources efficiently, water quality should be monitored repeatedly in certain periods, and important

factors that affect pollution change should be identified and appropriate measures should be taken [6-9]. In this thought, the water quality of the spring water was evaluated with the streams that feed Yuvacık Dam, which meets the drinking water needs of Kocaeli province.

MATERIAL AND METHOD

Definition and Features of the Study Area

Yuvacık basin is in the east of the Marmara region and approximately 16 km southeast of Kocaeli province İzmit district. Settlements of the basin; Kocaeli province Izmit district and Sakarya province Pamukova district to the southeast of the basin and some villages of Bursa province İznik district to the southwest. The Yuvacık basin, located between $40^0$32'-$40^0$41'north latitudes and $29^0$49'-$30^0$08' east longitudes, is 25.759 hectares [10]. The location of the Yuvacık basin is given in Figure 1.

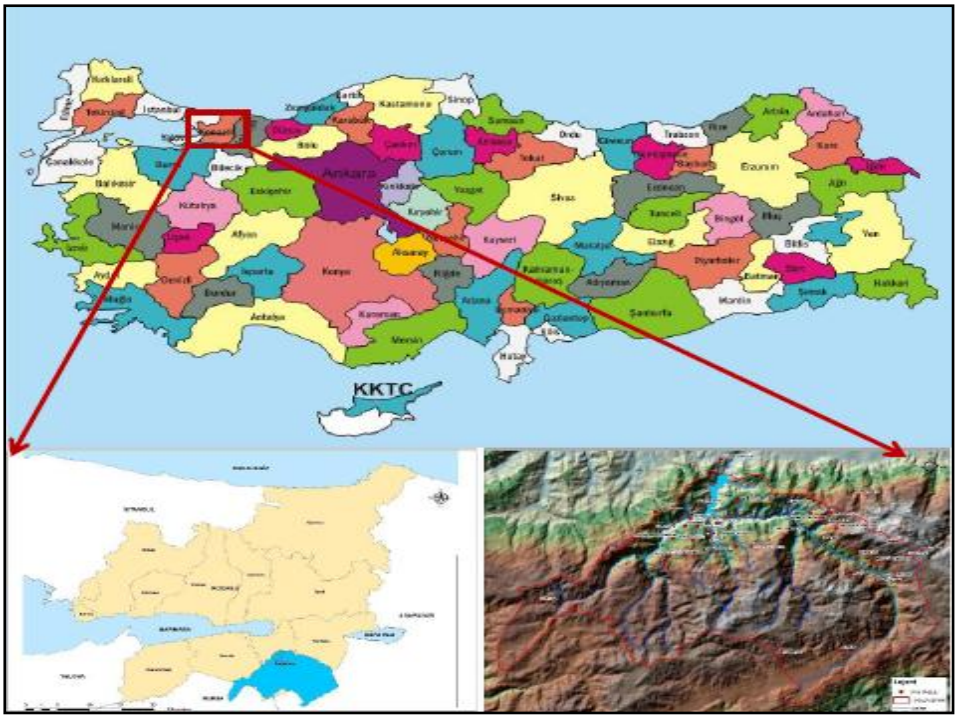

Figure 1. Yuvacık basin location and borders.

In the Yuvacık dam basin, there are many high flowing spring waters that directly supply drinking water to a part of Kocaeli province. These sources are Soğukpınar, Karakaya, Yaygınca, Karpuz Çatlatan, Karapınar, Gürlek, Sarıçökek, Serindere and Karadağ (Tepecik), respectively. Soğukpınar and Karakaya springs are located within the Kirazdere drainage basin, Yaygınca, Serindere, Karpuz Çatlatan, Sarıçökek, Gürlek and Karapınar springs are in Serindere drainage basin, and Karadağ (Tepecik) source is located in Kazandere drainage basin [11]. The Google Earth image showing the distribution of resources in the Yuvacık reservoir is given in Figure 2, and the coordinate information of the resources is given in Table 1.

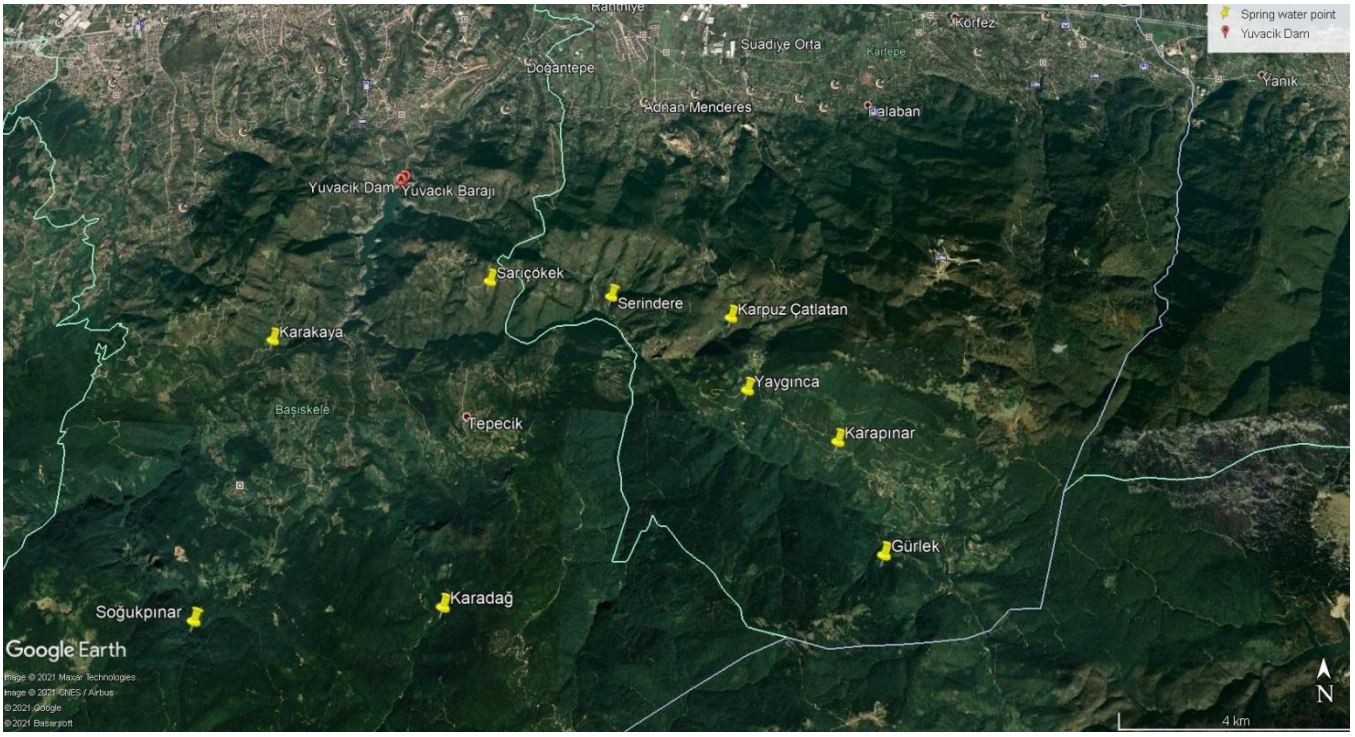

Figure 2. Google Earth image showing the distribution of resources in the Yuvacık reservoir.

Table 1. Coordinate information of the resources in the Yuvacık Dam basin.

Spring Water Point	X	Y	Altitude (m)
Soğukpınar	29° 55' 55.1316"	40° 35' 33.3761"	714
Karadağ (Tepecik)	29° 59' 05.8431"	40° 35' 39.7783"	798
Gürlek	30° 04' 43.6062"	40° 36' 07.1146"	830
Karapınar	30° 04' 13.3572"	40° 37' 16.1676"	704
Yaygınca	30° 03' 02.5072"	40° 37' 49.5070"	608
Karakaya	29° 56' 26.1775"	40° 38' 29.3188"	204

Serindere	30° 01' 10.4508"	40° 38' 55.7333"	287
Sarıçökek	30° 02' 13.7966"	40° 39' 05.5947"	599
Karpuz Çatlatan	30° 02' 50.6424"	40° 38' 37.1286"	603

Sampling Stations and Analysis Methods

Water sources that feed the reservoir are groundwater sources and superficial water sources. Water samples were taken in September 2016 and May 2017 to determine the water quality of the streams and groundwater resources feeding the Yuvacık dam basin. The coordinate information of the stream sampling locations is given in Table 2, and the location information of the groundwater sampling points is given in Table 3. Samples; It was taken in accordance with the "Water Pollution Control Regulation, Sampling and Analysis Methods Communiqué" and it was stored in glass bottles at + 4 ° C and transported to the laboratory environment. The analyzes were carried out in the laboratory of ISU General Directorate Laboratory Branch Office, which has an accreditation certificate. The methods used in the analysis and the devices (equipment)used are shown in Table 4.

Table 2. Coordinate information of stream sampling locations.

Sampling Locations	Longitude	Latitude
Kirazdere-2	29° 56' 38.5826" E	40° 38' 32.7250" N
Kirazdere-1	29° 56' 43.6708" E	40° 38' 37.6624" N
Kirazdere	29° 56' 44.2248" E	40° 38' 36.7549" N
Kazandere	29° 57' 36.7879" E	40° 38' 22.3381" N
Serindere	30° 01' 00.8934" E	40° 38' 48.2061" N

Table 3. Location information of groundwater sampling points.

Spring Water Point	X	Y
Soğukpınar	4495334,2531	494242,1203
Tepecik	4495529,6219	498726,5814
Gürlek	4496375,7147	506667,8431
Karapınar	4498505,1374	505954,9575
Yaygınca	4499532,3890	504289,0933

Karakaya	4500760,8999	494975,8028
Serindere	4501574,1799	501655,2095
Sarıçökek	4501878,8495	503143,3579
Karpuz Çatlatan	450100,11871	504009,4688

Table 4. Methods and equipment used in analysis.

Parameters	Unit	Method	Equipments
Temperature	(°C)	SM 2550 :B	Hq40 Hach Lange Multi
pH		SM 4500 H+ :B	Hq40 Hach Lange Multi
Conductivity	µs/Cm	SM 2510 :B	Hq40 Hach Lange Multi
DO	mg O_2/L	SM 4500 O :G	Hq40 Hach Lange Multi
Color			Spectrophotometer
COD	mg/L	SM 5220 :B	Phoro 300 Merc Uv Spectrophotometer
BOD	mg/L	SM 5210 :D	BOI Bottles, Incubator
Ammonium N	mg NH_4^+-N /L	TS EN ISO 14911	Continuous Flow Analyzer
Total Kjeldahl N	mg N/L	SM 4500 NORG :B	Automatic Nitrogen Protein Burning Device
Nitrate N	mg /L	TS EN ISO 14911	Ion Chromatography (IC)
Total P	µg/L /L	TS EN ISO 17294-2	Agilent 7800 ICP MS
Orthophosphate P	mg o-PO_4-P/L	SM 4500 P ve E	Inductively Coupled Plasma Mass Spectrometer (ICP MS)
Selenium	µg/L	TS EN ISO 17294-2	Continuous Flow Analyzer
Fluoride	µg F/L	TS EN ISO 10304-1	Agilent 7800 Icp Ms
Manganese	mg /L	TS EN ISO 17294-2	Inductively Coupled Plasma Mass Spectrometer (ICP MS)

The analysis results of the creeks feeding the Yuvacık dam basin were published in the Official Gazette dated 30/11/2012 and numbered 28483 "Surface Water Quality Regulation" (SWQR) Annex 5 Table 2 According to the Quality Criteria of Inland Surface Water Resources in terms of General Chemical and Physicochemical Parameters by Classes It has been evaluated. In accordance with the provisions of the "Regulation on the Protection of Groundwater Against Pollution and Deterioration" published in the Official Gazette dated 07/04/2012 and numbered 28257, samples were taken from groundwater resources for general purpose monitoring. Since there is no limit value for the monitoring parameters specified in the regulation and its annexes on the protection of groundwater against pollution and deterioration, the groundwater analysis results are also interpreted within the scope of SWQR Annex 5 Table 2 General Chemical and Physicochemical Parameters of the Inland Surface Water Resources in terms of their Classes.

RESULT AND DISCUSSION

Analysis Results of Surface Water Resources

In order to determine the water quality of the creeks in the Yuvacık Dam basin, water samples were taken from the streams in September 2016 and May 2017 periods. Within the scope of the study, sampling studies were carried out at three points from Kirazdere and at one point from other streams (Serindere and Kazandere). Analysis results of samples taken from streams in September 2016 and May 2017 are given in Table 5 and Table 6.

The analysis results in Table 5 and Table 6 are published in the Official Gazette dated 30/11/2012 and numbered 28483 "Surface Water Quality Regulation" (SWQR) Appendix 5 Table 2 According to Classes of Inland Surface Water Resources in terms of General Chemical and Physicochemical Parameters It has been evaluated according to the Quality Criteria. According to the analysis results, since the detection limit value for TP and TKN parameters is high, the water quality class of the creeks could not be evaluated in terms of these parameters. The streams in the Yuvacık Dam basin exhibit alkaline pH values. The pH values of the streams are generally similar to each other. In the May period (average pH: 8.39 ± 0.13), an increase of 0.8 units was observed in the pH value of the streams compared to the September period (average pH: 7.65 ± 0.19). In this case, it is thought that the surface flow and infiltration that occur due to the geological structure of the basin during the rainy period have an effect. An average of 10% decrease was observed in May (249 ± 26 µS / cm), when the feeding of the streams was relatively higher, compared to the September period (278 ± 28 µS / cm) due to the

dilution in the EC values of the streams. On the other hand, there has been an increase in the dissolved oxygen content of the streams (9.67 mg / l) compared to September (8.99 mg / l) due to excessive water intake.

When the water quality of the creeks is evaluated according to SWQR; Ammonium nitrogen is <0.2 mg / l, Class I, dissolved oxygen parameter> 8 mg / L, Class I, electrical conductivity (EC) parameter <400 µs / cm Class I, nitrate-nitrogen parameter <3 mg / Class I, pH parameter is in the range of 6-9, Class I, medium phosphate phosphorus parameter is <0.05 mg / l in each stream, Class I, fluoride parameter is ≤1000 µg / l Class I, selenium parameter is ≤ It is 10 µg / L and has a class I and manganese parameter of ≤100 µg / l, and the streams have a class I (very good) water quality feature. In the analyzes performed for the samples taken from Kirazdere-2, Kirazdere and Kazander in September, COD parameter was <25 mg / l and it showed I. class water quality characteristics. However, in the analyzes performed for the samples taken from Kirazdere-1 and Serindere streams, the COD parameter was measured as 25.2 mg / l and 26 mg / l, respectively. class (good) water quality feature.

Table 5. Surface water quality analysis results of the creeks in Yuvacık Dam basin (Dry period, September 2016).

Parameters	**Unit**	**Sampling Stations**				
		Kirazdere-1	**Kirazdere-2**	**Serindere**	**Kazandere**	**Kirazdere**
Ammonium nitrogen	mg NH_4^+-N/L	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02
Biochemical Oxygen Demand	mg/L	3,85	2,62	3,93	2,41	2,35
Dissolved Oxygen	mg/L	9,37	9,52	8,06	9,6	9,22
Conductivity	µS/cm	284	283	275	274	275
Chemical Oxygen Demand	mg/L	25,2	16,4	26	< 15	< 15
Nitrate Nitrogen	mg NO_3^--N/L	0,42	< 0,4	< 0,4	< 0,4	0,64
pH	-	7,7	7,74	7,32	7,84	7,84
Temperature	°C	14,2	14	15,4	14,5	16,4
Total Phosphorus	mg P/L	< 0,1	< 0,1	< 0,1	< 0,1	< 0,1
Total Kjeldahl Nitrogen	mg N/L	< 5	< 5	< 5	< 5	< 5
Orthophosphate phosphorus	(mg o-PO_4-P/L)	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02

Selenium	µg/L	< 5	< 5	< 5	< 5	< 5
Fluoride	µg F/L	< 100	< 100	< 100	< 100	< 100
Manganese	µg/L	< 100	< 100	< 100	< 100	< 100

Table 6. Surface water quality analysis results of creeks sampled in Yuvacık Dam basin (Wet Period, May 2017).

Parameters	Unit	Sampling Stations				
		Kirazdere-1	Kirazdere-2	Serindere	Kazandere	Kirazdere
Ammonium Nitrogen	mg NH_4^+-N/L	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02
Biochemical Oxygen Demand	mg/L	3,68	2,45	2,16	1,95	3,41
Dissolved Oxygen	mg /L	8,94	9,81	10,05	10,08	9,76
Conductivity	µS/cm	254	246	280	205,8	244
Chemical Oxygen Demand	mg/L	23	15,3	< 15	< 15	21,3
Nitrate Nitrogen	mg NO_3^--N/L	< 0,4	< 0,4	< 0,4	< 0,4	< 0,4
pH	-	8,17	8,37	8,48	8,39	8,47
Temperature	°C	15,7	14,5	12,1	13,7	15,8
Total Phosphorus	mg P/L	< 0,1	< 0,	< 0,1	< 0,1	< 0,1
Total Kjeldahl Nitrogen	mg N/L	< 5	< 5	< 5	< 5	< 5
Orthophosphate phosphorus	(mg o-PO_4-P/L)	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02
Selenium	µg/L	< 5	< 5	< 5	< 5	< 5
Fluoride	µg F/L	< 100	< 100	< 100	< 100	< 100
Manganese	µg/L	< 100	< 100	< 100	< 100	< 100

Analysis Results of Groundwater Resources

In accordance with the provisions of the "Regulation on the Protection of Groundwater Against Pollution and Deterioration" published in the Official Gazette dated 07/04/2012 and numbered 28257, samples were taken from groundwater resources for general purpose monitoring. Within the scope of the study, a sampling study was carried out from Karakaya, Soğukpınar, Karpuz Çatlatan, Gürlek, Sarıçökek, Yaygınca, Karapınar, Serindere and Tepecik springs. The analysis results of the samples taken from the sources in September 2016 and May 2017 are given in Table 7 and Table 8. General purpose monitoring has been carried out to provide information both as a result of changes in natural conditions and for use in assessing long-term increasing

trends in pollutant concentrations resulting from human activities. Some basic chemical and indicator parameters (such as oxygen content, pH value, conductivity, nitrate, ammonium, temperature) were analyzed for general purpose monitoring. Since no limit value is specified for the monitoring parameters specified in the Regulation on the Protection of Groundwater Against Pollution and Deterioration and its annexes, SWQR Appendix 5, which entered into force by being published in the Official Gazette dated 30/11/2012 and numbered 28483, Table 2 General Chemical and Physicochemical of Inland Surface Water Resources Parameters are interpreted within the scope of Quality Criteria According to their Classes. According to the regulation values; Ammonium nitrogen is <0.2 mg / l and I class, dissolved oxygen parameter is> 8 mg / l, I class, EC parameter is <400 µs / cm, I class, nitrate-nitrogen parameter is <3 mg / l. class and pH parameter are in the range of 6-9 and it shows I. class water quality.

Table 7. Quality analysis results of groundwater resources in the basin (Dry Period, September 2016).

	Sampling Stations												
Parameters	**Tepecik**	**Soğukpınar**	**Karakaya**	**Çeşme-3**	**Çeşme-4**	**Çeşme-6**	**Serindere**	**Sarıçökek**	**Karpuz**	**Yaygınca**	**Karapınar**	**Gürlek**	**Çeşme-7**
Ammonium Nitrogen (mg NH_4^+-N/L)	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02
Dissolved Oxygen	9,11	9,26	8,58	9,51	8,23	9,58	9,65	9,93	10,12	9,41	9,65	8,96	9,42
Conductivity (µs/cm)	213,9	303	294	296	379	279	274	239	263	271	271	266	161,9
Nitrate-Nitrogen (mg	< 0,4	< 0,4	< 0,4	2,3	2,1	< 0,4	< 0,4	< 0,4	< 0,4	< 0,4	< 0,4	< 0,4	< 0,4
pH	7,95	8,03	7,97	7,44	6,96	7,55	7,55	7,64	7,69	7,94	7,94	7,57	7,12
Temperature ^{o}C	13,6	12,9	12,9	12,4	14,1	12,2	12,3	11,7	10,9	10,6	11,5	12,7	11,1

Table 8. Quality analysis results of groundwater resources in the basin (Wet Period, May 2017)

	Sampling Stations												
Parameters	**Tepecik**	**Soğukpınar**	**Karakaya**	**Çeşme-3**	**Çeşme-4**	**Çeşme-6**	**Serindere**	**Sarıçökek**	**Karpuz**	**Yaygınca**	**Karapınar**	**Gürlek**	**Çeşme-7**
Ammonium Nitrogen (mg NH_4^+-N/L)	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02

DissolvedOxygen (mg/L)	9,64	9,97	8,93	9,77	8,96	9,7	10,04	9,76	10,26	10,14	9,47	10,11	10,48
Conductivity (µs/cm)	194,6	267	277	249	293	252	247	225	253	262	248	249	148
Nitrate-Nitrogen (mg NO_3^--N/L)	< 0,4	< 0,4	< 0,4	1,8	1,01	< 0,4	< 0,4	0,44	0,5	0,5	< 0,4	0,44	< 0,4
pH	7, 91	7,69	7,77	7,17	8,96	7,72	7,78	7,74	7,78	7,83	7,87	7,83	7,83
Temperature ^oC	9,5	9,6	11,5	10,9	11,1	11,3	10	10,5	9,8	9,6	10,2	9,5	10

CONCLUSION

Yuvacık basin drinking water sources in Kocaeli province were identified and their characteristic characteristics were determined and the quality categories of these waters were determined. Surface water samples were taken for two periods from the streams that feed the Yuvacık dam lake, which meets approximately 90% of the water need of Kocaeli, and the specified points representing the spring waters. The analysis results of drinking water sources were evaluated and raw water characterization and quality categories were made. Results and evaluations obtained as a result of the studies;

• The streams feeding the Yuvacık dam lake and the points representing the spring waters were determined.

• Yuvacık reservoir is divided into four sub-basins in terms of water management. These are Serindere, Kirazdere, Kazandere and Ara basin sub-basins.

• In the Yuvacık dam basin, there are many spring waters with high flow rates that directly supply drinking water to a part of Kocaeli province. These sources are Soğukpınar, Karakaya, Yaygınca, Karpuz Çatlatan, Karapınar, Gürlek, Sarıçökek, Serindere and Karadağ (Tepecik), respectively. Soğukpınar and Karakaya springs are located in the Kirazdere drainage basin, the Yaygınca, Serindere, Karpuz Çatlatan, Sarıçökek, Gürlek and Karapınar springs are in the Serindere drainage basin, and the Karadağ (Tepecik) spring is located within the Kazandere drainage basin.

• The highest flow rate source of the basin is the watermelon cracking source located in the Serindere sub-basin. Seasonal and post-precipitation changes observed in the flow of the Karpuz Çatlatan spring indicate that the source is fed by current rains and that the nutrition is quite fast.

• Sarıçökek, Serindere, Karapınar springs located in the Serindere basin are considered as spring waters with relatively low flow rates compared to Yaygınca and Gürlek springs.

• Due to the rugged topographic structure of the basin and its high slope, there are no collective sewer lines belonging to the villages. In residential areas, wastewater discharge is eliminated with the help of a leak and / or sealed septic tank. There are no existing or planned wastewater lines for the disposal of the wastewater of the villages in the basin (in absolute, short, medium and long distances) by treatment with the treatment plant. Necessary information and sanctions should be applied to collect the wastewater generated in residential areas in sealed septic tanks.

• The wastewater of the facilities located in the basin is collected in sealed septic tanks and discharged to the treatment facility outside the basin with the help of a vacuum truck. There is no wastewater treatment facility within the Yuvacık basin boundaries. However, it is thought that the trout facilities (restaurants) in the reservoir protection areas on Kirazdere will adversely affect the water quality, even if a little.

• There is no existing solid waste landfill within the basin boundaries, and solid wastes are collected in containers and taken to the solid waste disposal facility of Izmit Waste and Residues Treatment Incineration and Evaluation Corporation (İZAYDAŞ) outside the basin by Kocaeli Metropolitan Municipality. There is no negative situation regarding solid wastes.

• Since there are no factories and mines within the basin boundaries, it is not possible to talk about polluting loads.

• It is thought that heavy metals, solid materials and oil-grease may be transported to the basin in rainy weather due to the pollution originating from the İzmit-Yuvacık road, and the

pollution (CO2, SO2 etc.) caused by the use of solid fuel for heating in residential areas may be transported to the basin.

• Alternative natural treatment methods can be applied to minimize the pollution carried by surface waters originating from the highway.

• Creeks in the Yuvacık Dam basin exhibit alkaline pH values. The pH values of the streams are generally similar to each other. In the May period (average pH: 8.39 ± 0.13), an increase of 0.8 units was observed in the pH value of the streams compared to the September period (average pH: 7.65 ± 0.19). In this case, it is thought that the surface flow and infiltration that occur due to the geological structure of the basin during the rainy period have an effect.

• An average of 10% decrease was observed in the EC values of the streams in May (249 ± 26 µS / cm), when the recharge of the streams was relatively higher, compared to the September period (278 ± 28 µS / cm). On the other hand, there has been an increase in the dissolved oxygen content of the streams (9.67 mg / L) compared to September (8.99 mg / L) due to excessive water intake.

• When the water quality of the streams is evaluated according to SWQR; ammonium nitrogen is <0.2 mg / L, class I, dissolved oxygen parameter> 8 mg / L, class I, electrical conductivity (EC) parameter <400 µs / cm Class I, nitrate-nitrogen parameter <3 mg / L It is class I, pH parameter is between 6-9, class I, medium phosphate phosphorus parameter is <0.05 mg / L in each stream, I. class, fluoride parameter is ≤1000 µg / L. Class I, selenium parameter ≤ It is 10 µg / L and has a class I and a manganese parameter of ≤100 µg / L, and the streams have a class I (very good) water quality feature.

• In the analysis performed for the samples taken from Kirazdere-2, Kirazdere and Kazandere in September, COD parameter was <25 mg / L and it showed I. class water quality characteristics. However, in the analyzes performed for the samples taken from Kirazdere-1 and Serindere streams, the COD parameter was measured as 25.2 mg / L and 26 mg / L, respectively. class (good) water quality feature.

• According to the underground spring water regulation values; Ammonium nitrogen is <0.2 mg / L, I. class, dissolved oxygen parameter> 8 mg / L, I. class, EC parameter <400 µs / cm I. Class, nitrate-nitrogen parameter <3 mg / Lt. class and pH parameter are in the range of 6-9 and it shows I. class water quality.

Increasing the sewerage network throughout the country to prevent water pollution, preparing drinking water basin protection plans for each region, conducting basin-based observation, inspection and control studies of groundwater potential and quality parameters, monitoring surface waters and modeling water quality, for sustainable water resources management. The use of decision support systems and multi-criteria analysis methods, the implementation of an integrated water basin management system in solving all environmental problems of the basins, informing the public about the causes and consequences of water pollution will be extremely useful in minimizing pollution.

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