Alınteri Journal of Agricultural Sciences. 2017, 32(1): 69-79
Alınteri Zirai Bilimler Dergisi

Investigation of Water Quality and Pollution Level of Lower Melet River, Ordu, Turkey

Research / Araştırma

Received / Geliş Tarihi
06.06.2017

Accepted / Kabul Tarih
28.06.2017

DOI
10.28955/alinterizbd.319403

ISSN 2564-7814
e-ISSN 2587-2249

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Abstract: Some water quality parameters of the Lower Melet River were determined by taking monthly samples, starting in October 2013 and end up in September 2014. The means obtained data were given as (min–max) mean as follow; pH;(6.93 – 8.8) 7.96, dissolved oxygen (DO);(5.4-15.4) 11.4 mgL^{-1}, saturation (%);(59-201) 117, temperature;(4.6-27.2) 14°C, total dissolved solid (TDS);(106-320) 161 mgL^{-1}, conductivity (EC);(124-520) 216 μScm^{-1}, salinity;(0-0.4) 0.11 ppt, biochemical oxygen demand (BOD_5);(0.6-4.8) 2.3 mgL^{-1}, total alkalinity (TA);(55-100) 79 mgL^{-1} $CaCO_3$, total hardness (TH); (70-125) 97 mgL^{-1} $CaCO_3$, chlorophyll-a;(1.6-10.4) 3.78 μgL^{-1}, total ammonia nitrogen (TAN); (0.33-1.27) 0.53 mgL^{-1}, total phosphate (TP);(0.08-0.85) 0.40 mgL^{-1} soluble reactive phosphorus (SRP); (0.01-0.12) 0.04 mgL^{-1}, chlorine;(0.04-0.75) 0.19 mgL^{-1}, silica;(2.37-6.08) 4.51 mgL^{-1}, phenol; (0.04-1.77) 0.43 mgL^{-1}, nitrite; (0.01-0.12) 0.04 mgL^{-1}, nitrate;(0.29-3.39) 1.22 mgL^{-1}, sulphite;(1.93-3.65) 2.34 mgL^{-1}, sulphate;(1.62-13.29) 10.42 mgL^{-1}, surfactant (anionic);(0.33-1.62) 0.97 mgL^{-1}, potassium;(2.75-15.4) 7.2 mgL^{-1}, total suspended solids (TSS);(8.45-147.7) 49.75 mgL^{-1} , and redox potential ;(-156 / -28) -86.78 mV. Sediment organic matter % and pH were averaged as (2.9-9.1) 5.77 and (6.71-8.3) 7.53, respectively. Obtained data showed that the water quality of Melet River may suitable for irrigation but may not be a suitable living habitat for the living beings. According to the class of surface water quality regulation getting into the category of mild contaminated according it's average total phosphate rate of 0.40 mgL^{-1}, TAN level of 0.53 mgL^{-1}, nitrite rate of 0.04 mgL^{-1} and severely contaminated according it's average surfactant (anionic) level of 0.97 mgL^{-1} and phenol level of 0.43 mgL^{-1}.

Keywords: Water quality, pollution, Melet River, phenol, surfactant

Aşağı Melet Irmağı (Ordu, Türkiye) Su Kalitesi ve Kirlilik Düzeyinin Araştırılması

Öz: Aşağı Melet Irmağının bazı su kalitesi parametrelerinin belirlendiği bu çalışma Ekim 2013 ile Eylül 2014 tarihleri arasında aylık su örnekleri toplanarak yürütülmüştür. Elde edilen veriler minimum, maksimum ve ortalama değerler şeklinde sunulmuştur; pH;(6,93–8,8) 7,96, Çözünmüş oksijen (ÇO);(5,4-15,4) 11,4 mgL^{-1}, saturasyon; % (59-201) 117, sıcaklık;(4,6-27,2) 14°C, toplam çözünmüş madde (TÇM);(106-320) 161 mgL^{-1},İletkenlik; (124-520) 216 μScm^{-1}, Tuzluluk;(0-0,4) 0,11 ppt, biyolojik oksijen ihtiyacı ($BOİ_5$); (0,6-4,8) 2,3 mgL^{-1}, toplam alkalinite (TA); (55-100) 79 mgL^{-1} $CaCO_3$ toplam sertlik (TS); (70-125) 97 mgL^{-1} $CaCO_3$, klorofil-a; (1,6-10,4) 3,78 μgL^{-1}, toplam amonyak azotu (TAN);(0,33-1,27) 0,53 mgL^{-1} toplam fosfor (TF);(0,08-0,85) 0,40 mgL^{-1} çözünebilir reaktif fosfat (ÇRF);(0,01-0,12) 0,04 mgL^{-1}, klorür; (0,04-0,75) 0,19 mgL^{-1}, silisyum; (2,37-6,08) 4.51 mgL^{-1}, fenol; (0,04-1,77) 0,43 mgL^{-1}, nitrit; (0,01-0,12) 0,04 mgL^{-1}, nitrat;(0,29-3,39) 1,22 mgL^{-1}, sülfit;(1,93-3,65) 2,34 mgL^{-1}, sülfat;(1,62-13,29) 10,42 mgL^{-1}, anyonik deterjan;(0,33-1,62) 0,97 mgL^{-1}, potasyum;(2,75-15,4) 7,2 mgL^{-1}, askıda katı madde (AKM);(8,45-147,7) 49,75 mgL^{-1} , ve redox potansiyeli; (-156/-28) -86,78 mV. Sediment organik madde oranı % (2,9-9,1) 5,77 ve sediment pH'ı (6,71-8,3) 7,53 bulunmuştur. Elde edilen verilere göre Melet Irmağının sulama için uygun ancak yaşayan habitat için uygun olmadığı belirlenmiştir. Yerüstü Su Kalitesi Yönetmeliği'ne göre 0,40 mgL^{-1} fosfat, 0,53 mgL^{-1} TAN, 0,04 mgL^{-1} nitrit seviyeleri ile orta derece kirli ve 0,97 mgL^{-1} surfaktant(anyonik) ve 0,43 mgL^{-1} fenol oranlarıyla ciddi derecede kirli su sınıfına girmektedir.

Anahtar Kelimeler: Su kalitesi, kirlilik, Melet Irmağı, fenol, anyonik deterjan

1. INTRODUCTION

The quality and permanence of natural surface waters is a vital issue today. Surface waters are the most vulnerable sources to pollution and worldwide deterioration of water quality from both anthropogenic influences such as urban, industrial and agricultural activities, increasing consumption of water resources and natural processes such as changes in precipitation inputs, erosion, and weathering of crustal materials impair their use for drinking, industrial, agricultural, recreation or other purposes (Tepe 2009, Boyd and Tucker 2014).

The Melet River, a major water source of Ordu, originates from a natural reservoir in the forested area with elevation of about 940 m between North latitude of 40°18' and East longitude of 37°49'. The river traverses a total distance of about 165 km before finally merging with Black Sea. The region has steep topography and the altitude of the catchment area extends to 1,469 meters. The river serves as a major source of domestic water supply of the area and Ordu city. The river during its course receives pollution load both from the point and non-point sources. It receives agricultural run-off from its catchments area directly or through its tributaries and wastewater drains.

Although vital importance of the Melet River for Ordu city and its surrounding area as both drinking and irrigation water source, studies on its water quality has been very limited. (Taş, 2006), (Gedik et al. 2010) and (Bayram et al. 2013) reported some water quality parameters from Derbent Dam Lake, Fırtına Stream, and Harşit Stream, respectively which are in the same region with Melet River.

The objectives of this study were: (1) To have an overall picture of the environmental impacts of pollutants and human actions on Melet River; (2) pollution loads and water quality determination; (3) comparison of present data with previous published data from close neighborhood and worldwide.

2. MATERIAL AND METHODS

Study Area

Melet River, with 1162 km^2 watershed, 165 km main channel length and 49 side creeks, is the biggest and important freshwater source in the close vicinity of Ordu, Turkey between 40° North and 37° East (Fig. 1). The area around the source of the river is one of the Turkish fabulous plateaus and there are numerous recreational facilities including restaurants and hotels. The land uses within the basin largely consist of, agricultural, commercial, industrial, mining, livestock, pasture, row crops, forestry, and water. Series of water quality problems have been identified from both point and non-point source pollutants such as nutrients, hydrocarbons, pesticides, and heavy metals. The construction of hydroelectric power station on the river has also changed the natural stream bed. Water samples were taken from two different stations. The first station was in mountain area, right below the town called Ulubey. Ulubey with the altitude of 599 m, the population of 7,000 and the surface area of 256 km^2 is the third largest town of Ordu city. The sewage of the town directly drain to the creek without any treatments. Hazelnut production is the main income of the town and pesticide and fertilizers were administered intensely. The second station was on about 200 m inside from the Black Sea coastline. Ordu Industrial Area is located right on the both side of the creek around the second station, and the plants were drained their effluent in it. Ordu Municipal Wastewater Treatment Plant has also opened right next to this station in June 2014 while the present study had still been in process.

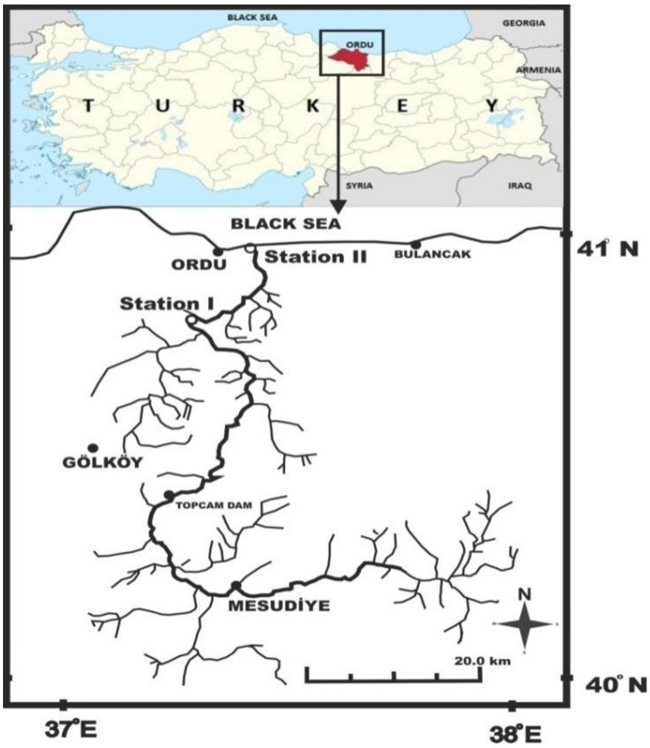

Figure 1. Map of the study area with sampling stations.

Water Analyses

The study was carried out between October 2013 and September 2014 on a monthly basis. Sampling bottles were washed with 1-2% HCl solutions, a day before use, then rinsed with distilled water, and dried in the drying oven. The sample bottles were labeled with date. All the chemicals used were of Analytic Grade. Water samples were taken from 10 cm depth by holding the bottles upward, and immediately transferred to the laboratories for analyses. Dissolved oxygen, temperature, pH and salinity were measured directly at the field by means of digital instruments (oxygen and salinity: YSI model 550A oxygen meter; pH: Hanna model HI8314 pH meter).

Chlorophyll-*a* concentration was determined spectrophotometrically with 90 % acetone methanol method. Other water quality parameters, such as total alkalinity and hardness, total ammonia nitrogen, nitrite, nitrate, phosphate, sulphite, sulphate, chlorine, potassium, silica, surfactant, and phenol were measured on the same day in the Giresun University, Department of Biology Laboratories. Titration methods were used for total alkalinity and total hardness, and the results of both analyses were expressed as mg/L $CaCO_3$. Nitrate (NO_3), nitrite (NO_2^-) and total ammonia nitrogen (TAN) (NH_3 + NH_4^+) as well as phosphate (PO_4^3) measurements were carried out according to standard procedures by using a Shimadzu brand UV-mini 1240UV model spectrophotometer. Water analyses were done according to procedures described by Boyd and Tucker (1992).

Sediment Analyses

Sediment samples were collected monthly from both station by taking approximately 100 g mud on 5 cm surface of the bottom. Mud samples were brought to the lab in polyethylene bags in the same day and let them dry for 24 hours in the drying oven at 105 °C. Sediment analyses were done according to procedures described by Boyd (1995).

Statistical Analyses

Statistical analyses were performed with SPSS 17. The probability level for rejection of the null hypothesis was 0.05. Difference of each parameter by stations was compared by using independent samples t-test ($p<0.05$).

3. RESULTS

The results of the study were given in table 1 and presented as separate subtitles by individual parameters below. There were no significant differences among stations as measured water quality parameters ($p<0.05$). Annual rainfall (mm) and air temperature (^oC) data of Ordu city were given in fig 2 (MGM, 2015). Monthly changes of the mean levels of water quality parameters were shown in fig 3.

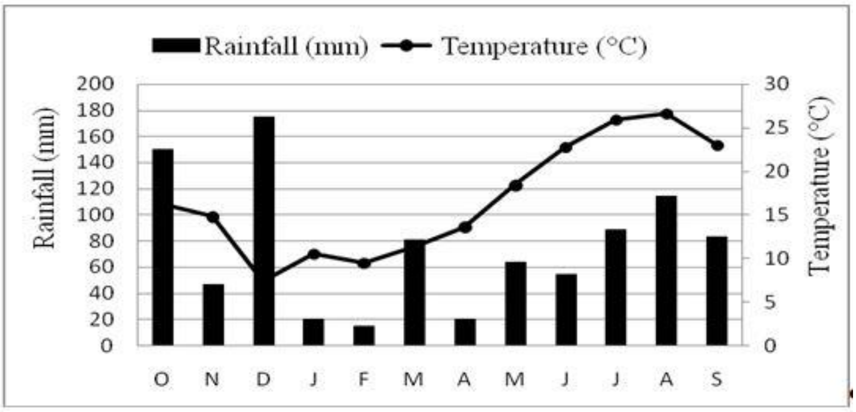

Figure 2. Rainfall (mm) and temperature (^oC) values of Ordu city during the study period (MGM, 2015).

pH is the indicator of acidic or alkaline condition of water quality. The standard for any purpose such as drinking, irrigation and industrial in terms of pH is 6.5-8.5. In table 1, pH indicates slightly alkaline conditions. pH values, the mean, minimum and maximum were 7.96, 6.93 recorded in November and 8.80 recorded in September, respectively. The mean pH values were 8.17, and 7.74 for the station 1st, and 2nd, respectively.

The average dissolved oxygen value was 11.4 mgL^{-1}, with the minimum of 5.4 mgL^{-1} in August, and the maximum of 15.4 mgL^{-1} in December. Oxygen saturation was averaged as 117% which indicate that Melet River can be classified as clean water.

The temperature values varied from 4.6°C to 27.2°C on January and August, respectively, with the overall mean value of 14°C . The mean temperature values were 13.8°C and 14.2°C for the station 1st, and 2nd , respectively. Water temperature has both direct and indirect effects on almost all aspects of river ecology, such as the amount of dissolved oxygen. The seasonal temperature levels of the creek were exceeded the requirement of trout, native fish species of the Melet River.

Total Dissolved Solids (TDS) is a measure of all constituents dissolved in water. The inorganic anions dissolved in water include carbonates, chlorines, sulfates and nitrates. The inorganic cations include sodium, potassium, calcium and magnesium. The mean, minimum and maximum Total dissolved solid values were 161 mgL^{-1}, 106 mgL^{-1} measured in March and 320 mgL^{-1} measured in September, respectively. The average values of stations were 153 mgL^{-1}, and 171 mgL^{-1}, respectively without no significant differences between them.

The mean conductivity (EC) values ranged from 124 to 520 µScm^{-1} in March and September, respectively. This indicates that the creek water had different quality in different seasons. The higher EC Values indicate the presence of higher concentration of dissolved salts in the river water and EC values are a good measure of the relative difference in water quality between different aquifers. The mean conductivity values were 196.75 µScm^{-1}, and 237.17 µScm^{-1} for the station 1st, and 2nd, respectively.

The annual mean of the BOD values were calculated as 2.3 mgL^{-1} with the maximum value of 4.8 mgL^{-1} measured in both October and November and the minimum value of 0.6 mgL^{-1} measured in August. Measurements from stations were averaged as 2.2 mgL^{-1}, and 2.5 mgL^{-1} for the first, and the second stations, respectively.

The standard desirable limit of alkalinity in drinking water is 120 ppm Anonymous (Anonymous, 2011). The maximum permissible level is 600 ppm. Total alkalinity values of Melet River water samples varied from 55 to 100 mgL^{-1} in March and November, respectively with the overall mean of 79 mgL^{-1}. The mean total alkalinity values were 79 mgL^{-1} for both stations.

Anonymous (1996) specified the total hardness to be within 200-600 mgL^{-1} of $CaCO_3$. Hardness values of Melet River water samples varied from 70 to 125 mgL^{-1} $CaCO_3$ on March and October, respectively. Hardness values parallel to alkalinity were lower during rainy season and higher during summer seasons. Total hardness values were 97 mgL^{-1} $CaCO_3$ as annual average.
Chlorophyll-a averaged as 3.78 μgL^{-1} for the whole year and showed its minimum value with 1.60 μgL^{-1} in November and February and the maximum value with 10.40 μgL^{-1} in August. The mean Chlorophyll-a levels of the stations were 3.46 μgL^{1}, and 4.09 μgL^{-1} for the first, and the second stations, respectively.

Total Ammonia Nitrogen (TAN) concentrations were changed from as low as 0.33 mgL^{-1} to as high as 1.27 mgL^{-1} measured in January and December, respectively. The mean TAN value of stations were calculated as 0.53 mgL^{-1} for the both stations, with the overall mean value of the study as 0.53 mgL^{-1}
The average total phosphate concentration was 0.40 mgL^{-1} with the minimum value of 0.08 mgL^{-1}, and the maximum value of 0.85 mgL^{-1}, recorded in May and October, respectively. Annual average values of total phosphorus were 0.38 mgL^{-1}, and 0.42 mgL^{-1} for the station 1st, and 2nd, respectively.
Soluble reactive phosphorus levels were averaged as 0.04 mgL^{-1} with the minimum of 0.01 mgL^{-1} and the maximum 0.12 mgL^{-1} in May and December, respectively. Annual average values of SRP were 0.04 $mgL^{-1}$for the both stations.

The mean value of chlorine was 0.20 mgL^{-1} with the maximum value of 0.75 mgL^{-1}, and the minimum 0.04 mgL^{-1} measured in July and October, respectively. The first and second stations chlorine levels were averaged as 0.17 mgL^{-1}, and 0.23 mgL^{-1} , respectively.

Silica (SiO_2) is an oxide of silicon, and is present in almost all minerals: It is found in surface and well water in the range of 1 - 100 mgL^{-1}. The mean Silica value was 4.51 mgL^{-1} with the maximum value of 6.08 mgL^{-1} measured in December, and the minimum value of 2.37 mgL^{-1} measured in April. The mean silica levels of the stations were 4.49 mgL^{-1} and 4.53 mgL^{-1} for the first and the second stations, respectively.

The average phenol value of the study was 0.43 mgL^{-1} with the minimum of 0.04 mgL^{-1}, measured in January and the maximum of 1.41 mgL^{-1} measured in July. Stations means were 0.34 mgL^{-1}, and 0.51 mgL^{-1} for the 1st, and 2nd stations, respectively.

The average nitrite level was 0.04 mgL^{-1} with the maximum level of 0.12 mgL^{-1} measured in January and the minimum level of 0.01 mgL^{-1} measured in July. The mean nitrite levels of the stations were 0.04 mgL^{-1} for the both stations.

The average nitrate level was 1.22 mgL^{-1} with the maximum value of 3.39 mgL^{-1} measured in April and the minimum 0.29 mgL^{-1} measured in October. The mean nitrate value of stations were 1.08 mgL^{-1}, and 1.36 mgL^{-1} for the first, and second stations, respectively.

The average sulphite (SO_3^{-2}) value of the study was 2.34 mgL^{-1} with the minimum of 1.93 mgL^{-1}, measured in February and the maximum of 3.65 mgL^{-1} measured in July. Stations means were 2.25 mgL^{-1}, and 2.42 mgL^{-1} for the 1st, and 2nd stations, respectively.

Sulphate values of Melet River water samples varied from 4.85 to 23.45 mgL^{-1} in April and September, respectively with the overall mean of 10.42 mgL^{-1}. The mean sulphate values of the stations were 8.43 mgL^{-1} and 12.42 mgL^{-1} for the 1st, and 2nd stations, respectively.

Surfactants are used by consumers in a wide array of products, mainly as personal care products and detergents. The mean anionic surfactant concentration in the water was 0.97 mgL^{-1} which is above the permissible level, 0.2 mgL^{-1}, according to Anonymous (2004).The minimum and the maximum values were 0.12 mgL^{-1}, and 1.62 mgL^{-1} measured in March and September, respectively. Stations means were 1.09 mgL^{-1}, and 0.85 mgL^{-1} for the 1st, and 2nd stations, respectively.

Potassium levels of the present study averaged as 7.20 mgL^{-1} with the minimum value of 2.75 mgL^{-1} occurred in January and the maximum value of 15.40 mgL^{-1} occurred in September. The mean potassium values of the stations were 6.41 mgL^{-1} and 7.98 mgL^{-1} for the 1st, and 2nd stations, respectively.

The mean TSS value was 49.8 mgL^{-1} with the maximum value of 104 mgL^{-1} measured in June and the minimum value of 27 mgL^{-1} measured in September. Stations' means were 37 mgL^{-1}, and 62.5 mgL^{-1} for the first, and second stations, respectively

The average Oxidation-reduction value for the last seven months of the study was -86.78 mV with the minimum of -136 mV, measured in June and the maximum of -50 mV measured in April. Stations means were -105.7 mV, and -67.9 mV for the 1st, and 2nd stations, respectively.

Organic matter % and pH of sediment were measured during the twelve months long study period on collected sediment samples. Organic matter % was averaged as 5.8 % with the maximum value of 9.1 % measured in April and the minimum value of 2.9 % measured in February. Station values were 5.6 %, and 5.9 % for the 1st, and 2nd stations, respectively.

pH measurements in sediment was averaged as 7.53 with the maximum in December as 8.30 and the minimum in October as 6.71, indicating slight alkaline nature of the sediments.. The stations' means were 7.66 and 7.40 for the 1st, and , 2nd stations, respectively.

Table 1. Water and sediment quality parameters of Lower Melet River by stations and annual means ± SE.

Parameters	Station 1 Mean±SE	Station 2 Mean±SE	Annual Mean±SE
pH	8.17±0.18	7.74±0.14	7.96±0.12
Dissolved oxygen (mg/L)	11.62±0.81	11.25±0.81	11.40±0.56
Saturasyon (%)	116.42±8.43	115.50±9.58	117±6.24
Temperature (°C)	13.84±2.06	14.20±2.14	14±1.45
TDS (mg/L)	152.67±13.14	170.92±20.51	161±12.06
Conductivity (µScm^{-1})	195.75±13.80	237.17±39.09	216±20.72
Salinity (ppt)	0.08±0.01	0.13±0.02	0.11±0.14
BOD_5 (mg/L)	2.16±.27	2.52±0.41	2.30±0.24
Total alkalinity (mg/L $CaCO_3$)	78.58±2.89	79±3.89	79±2.37
Total hardness (mg/L $CaCO_3$)	95.83±3.35	98.33±4.71	97±2.84
Chlorophyll-a (µg/L)	3.46±.47	4.09±0.68	3.78±0.41
TAN (mg/L)	0.52±0.07	0.53±0.04	0.53±0.04
Total phosphate (mg/L)	0.37±0.05	0.42±0.05	0.40±0.04
SRP (mg/L)	0.04±.00	0.04±0.00	0.04±0.00
Chlorine (mg/L)	0.17±0.04	0.22±0.05	0.19±0.03
Silica (mg/L)	4.49±0.29	4.53±0.29	4.51±0.20
Phenol (mg/L)	0.34±0.11	0.51±0.13	0.43±0.08
Nitrite (mg/L)	0.03±0.00	0.04±0.00	0.04±0.00
Nitrate (mg/L)	1.07±0.16	1.36±0.22	1.22±0.13
Sulphite (mg/L)	2.25±0.12	2.42±0.13	2.34±0.08
Sulphate (mg/L)	8.43±1.96	12.42±2.36	10.42±2.01
Anionic Surfactant (mg/L)	1.09±0.11	0.85±0.10	0.97±0.08
Potassium (mg/L)	6.41±0.75	7.98±1.13	7.2±0.68
TSS (mg/L)	37±6.54	62.5±16.8	49.75±9.64
Redox potential (mV)	-105±5.49	-67.85±5.15	-86.78±6.37
Sediment Organic Matters (%)	5.67±0.65	5.88±0.41	5.77±0.38
Sediment pH	7.66±0.08	7.40±0.09	7.53±0.06

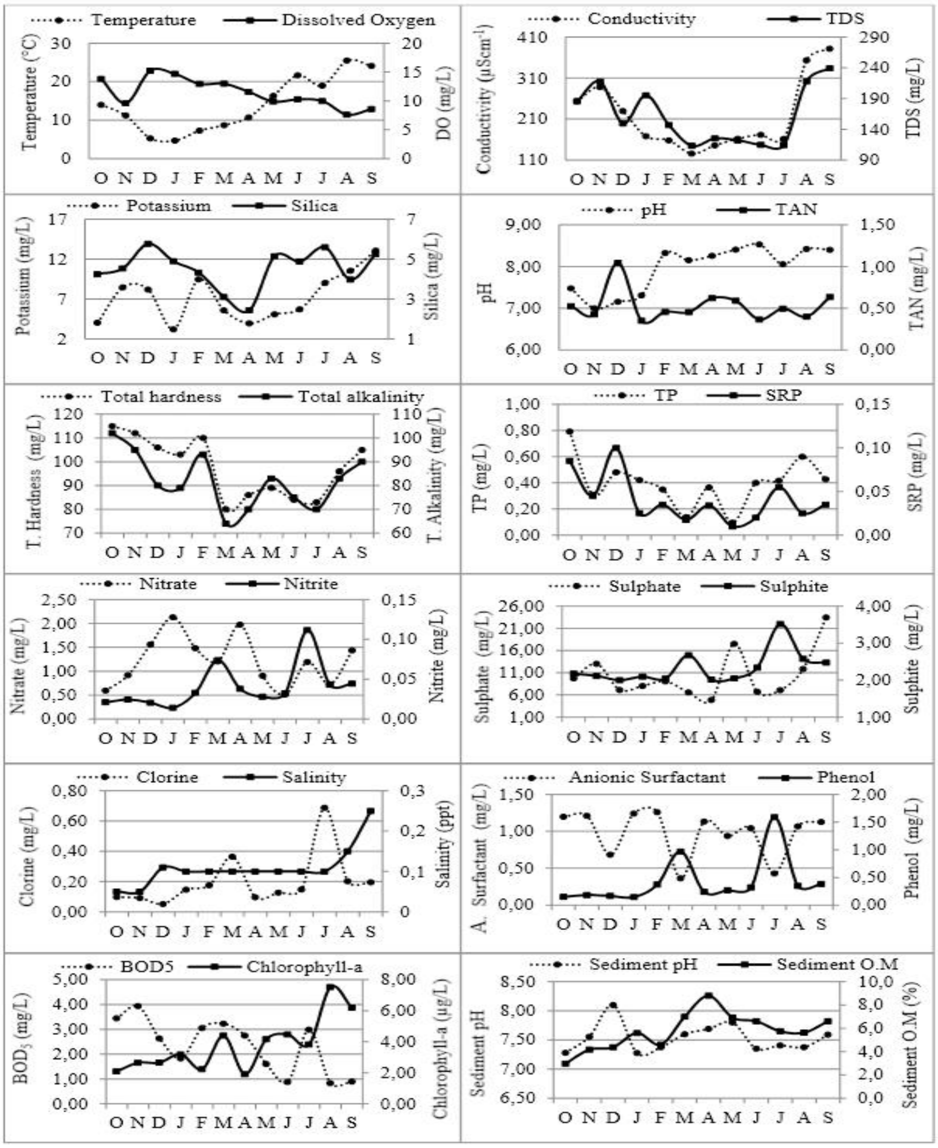

Figure 3. Monthly changes of the mean levels of water quality parameters.

4. DISCUSSIONS

Temperature and Dissolved Oxygen levels were both acceptable in all stations. There was an inverse relation between these two parameters through the year except November. Heavy rain in November caused a dramatic decrease in dissolved oxygen levels on that month.

pH measurements of the study were always above the neutral level of 7 showing the slightly alkaline conditions of Melet River. Rivers with a pH of 5.5 and below are particularly at risk. The pH of the surface water can be lowered by organic acids from decaying vegetation or the dissolution of sulphide minerals. The risk associated with low pH was not subject for Melet River since, pH levels were all above 6.93.

Conductivity levels were consistently parallel to TDS levels all year round. There was a jump at the levels of both parameters on August. High TDS levels can make water taste like minerals and make it unpleasant to drink, and can also cause water balance problems for organisms. The max TDS level of the study measured as 320 mgL^{-1} on August. On the contrary, low TDS levels may limit growth of aquatic life. TDS can cause toxicity through increases in salinity, changes in the ionic composition of the water and toxicity of individual ions (Phyllis and Lawrence 2007). Electrical conductivity (EC) is widely used for monitoring the mixing of fresh water and saline water, separating stream hydrographs, and geophysical mapping of contaminated groundwater. Especially on the second sampling station mixing from the saline water month by month were observed. In general, high conductivity values were common towards the end of the dry season during a period characterized by little or no inflow. Low records were made at the end of the wet season. The mean electrical conductivity (EC) of 216 µS/cm was very similar to level of 201.34 µs/cm from Çınarlı Stream (Mutlu et al. 2016) but far below the levels recorded from the Biga Stream which varies between 423 µS/cm and 1197 µS/cm (Hacıoglu and Dulger 2009).

Total alkalinity (TA) and total hardness (TH) levels were closely parallel to each other showing us that they are mainly originated from limestone. The observed TA and TH values were well within the limits prescribed by Anonymous (1996), which is fit for drinking purpose and irrigation purpose too. High TA and TH levels were recorded around the end of the dry season while low levels were noted in the middle of the rain season. Alkalinity values were lower during rainy season and higher during summer seasons. The cause of alkalinity is the minerals which dissolve in water from soil. The various ionic species that contribute to alkalinity includes bicarbonates, hydroxides, phosphates borates and organic acids. The sewage, drain water, industrial effluents may lead to increase in alkalinity of surface water in future course of time.

The seasonal increase in both total and soluble reactive phosphorus levels in summer months in Melet River can be attributed to increased residential population and agricultural activities because of hazelnuts harvest.

High values of TSS indicate an enhanced pollution status of a water body. Downstream sites were heavily polluted with very high content of TSS, while the content of SS was lower in the upstream sites, which indicated that the polluting process of the river was acting. The river water contained the highest TSS concentration in June, dry season and on the contrary during the rainy season, a large amount of water input diluted the TSS in the river in September.

Significant positive correlation was found with BOD_5, TAN and TSS, and negative correlation with DO and TSS. It was owing to that TSS can adsorb many organic matters and microorganisms (Ling et al. 2002).

BOD_5 is another important factors used to assess the water quality regarding organic matter both suspended and dissolved. The high BOD_5 values in the downstream sites indicated organic matter being input during its course. The range of BOD_5 levels (0.6-4.8 mgL^{-1}) in the present study were in agreement with the levels of a study from Brook Kuruçay (0.05-1.34 mgL^{-1}) (Mutlu and Uncumusaoğlu 2016).

At present, one of the most common ecological problems of inland water bodies is eutrophication. Nitrogen and phosphorus are main nutrients enriched in water body. The geology of the drainage basin is the principle factor that determines the phosphorus level in rivers (Tanyolaç, 2011). The mean total phosphorus level of lower Melet River (0.39 mgL^{-1}) was similar to that of Ulubat Lake (0.42 mgL^{-1}) (Iscen et al. 2008), but greater than that of Gölbaşı Lake (0.22 mgL^{-1}) (Bozkurt and Tepe, 2011). Land runoff and pollutants from the hazelnut gardens should be the main input resources of nutrient for Melet River. As spring is the agriculture time along the river, surplus nitrogen and phosphorous are fertilized in spring. Therefore, river water contained the highest nutrient concentration in spring and summer. However, the highest NO_3 and the lowest NO_2 values were found in January, due to the highest DO values in that month. Nitrification process needs not only certain amount of nitrogen but also oxygen existing in water body. DO value is a key factor relating to nitrogen removal capacity by nitrification-denitrification in surface water. TAN concentrations (0.53 mgL^{-1}) were above the Turkish standard value of 0.2 indicating slight eutrophication (class II) in Melet River (Anonymous 2015).

Phenols are an important group of pollutants which enter water bodies in the waste discharges of many different industries. The most common anthropogenic sources of phenol in natural water include coal tar (Michałowicz, and Duda, 2007) and waste water from manufacturing industries such as resins, plastics, fibers, adhesives, iron, steel, aluminum, leather, rubber (Gardziella at al. 2013), and effluents from synthetic fuel manufacturing, paper pulp mills (Couto, and Herrera, 2006) and wood treatment facilities (Goerlitz et al. 1985). Concentrations of phenols in unpolluted waters are usually less than 0.02 mgL^{-1}. However, toxic effects on fish can be observed at concentrations of 0.01 mgL^{-1} and above according to the Anonymous (1996) and 0.06 – 0.4 mgL^{-1} according to Anonymous (1984). Phenol and surfactants levels of lower Melet River were in opposite relation through the year showing that surfactants suppress phenol concentrations. Anionic surfactant concentration in water was above the permissible level of 0.2 mgL^{-1} according to Anonymous (2004). Our results (0.97 mgL^{-1}) are far higher than the data obtained by similar studies in other countries where sewage treatment systems have been established such as Orbetello Lagoon (0.070 mgL^{-1}), Southern Tuscany, Italy (Renzi et al. 2012).

Chlorine and sulphates are main anions of natural waters. They are not always come from minerals, they can come from black waters, waters which are coming from industry etc. Sulphates are indicators that usually are present in water as result of land. Other source of sulphates are polluted waters. If concentration of sulphates is above the allocated value, its present makes water more aggressive. Thus, sulfate is a constituent of TDS and may form salts with sodium, potassium, magnesium and other cations. Sulfate (SO_4^{2-}) is widely distributed in nature and may be present in natural waters at concentrations ranging from a few to several hundred milligrams per liter. The average sulphate level from Horohon Creek were found as 3.99 mg/L (Mutlu et al. 2013) which was very similar to present study The average sulphate level from Horohon Creek were found as 3.99 mg/L (Mutlu et al. 2013). Cl^- concentrations were detected to show the variations of alkalinity in the river. Chlorines are important in detecting the contamination of surface water by waste water and effluents (Ijeoma K and Achi OK 2011). The permissible limits of chlorine in drinking water are 5 ppm (Anonymous, 2011). The values of chlorine observed in the present study (0.19 mgL^{-1}) were very low. The chlorine salts in excess of 100 ppm give salty taste to water. When combined with calcium and magnesium, may increase the corrosive activity of water. Maximum salinity was observed in September, the dry season. Salinity showed no specific relation with other characteristics.

Silica level in river water is primarily derived from the weathering of silicate rocks under the influence of CO_2 (Chapman and WHO, 1996). Actual concentration in rivers depends on the mobility of surrounding soils. Summer months had higher levels of Silica when compared to winter months confirms that river inflow plays an important role in regulating levels at the Lower Melet River. Inverse relation has been recorded from Yarseli Lake, Hatay, Turkey with higher silica levels in winter (Tepe et al. 2005). Similar silica levels (7.6 – 17.7 mgL^{-1}) were reported from Arsuz Creek, Hatay (Tepe and Mutlu, 2004).

The higher chlorophyll-a values were reached in summer and during winter and autumn chlorophyll-a was lower than 5 μgL^{-1}. Unfavorable conditions, such as high amount of suspended solids carried from the river and elevated level of pollutants, that inhibit extensive algal development in Melet River. The elevated levels of chlorophyll-a reported in summer can be explained as a direct consequence of the summer solar radiation peak plus the over-enrichment of nutrients such as SRP and nitrite. Elevated summer chlorophyll-a concentrations were also reported from Sarıçay Creek (23.42 μgL^{-1}) (Akbulut et al. 2010).

The decomposition of organic matter in bed sediment consumes oxygen from the surface water which potentially adverse effects on fish and benthic organism. Organic matter % was averaged as 5.8 % with the maximum value of 9.1 % measured in April and the minimum value of 2.9 % measured in February. Our results were in consistent with the organic content of the sediment samples from Berdan River (Tarsus – Mersin), which varied between 3.62% and 8.25% with a mean value of 6.70% (Ozbay et al. 2013). Rainfall caused an increase in sediment organic matter levels, which originated from water runoff of intensive agriculture, pasture activities and untreated wastewater discharges (Palma et al. 2010)

The detailed study on the physico-chemical water quality of the Melet River over a period of one year revealed that the water is not suitable for drinking and skeptical for irrigation purposes. The present water quality study provides an informative data and helps to understand the contamination of wastewater in Melet River and influences the ecology of river. The Melet River receives pollutants both organic and inorganic resources, were found to originate from illegal logging, agricultural activities, unsustainable development and household activities of people. These waste materials were ultimately contaminating the river water. Melet River may classified as mild contaminated according it's average total phosphate rate of 0.40 mgL^{-1}, TAN level of 0.53 mgL^{-1}, nitrite rate of 0.04 mgL^{-1} and severely contaminated according it's average surfactant (anionic) level of 0.97 mgL^{-1} and phenol level of 0.42 mgL^{-1} when comparing with the standards released by national and international organizations. (Anonymous 1996, Anonymous, 2011 Anonymous 2015).

ANCKNOWLEDGEMENT
The authors are grateful for the assistance from lecturer Huseyin Kara, Faculty of Education, Giresun University, for his support to prepare figures and the map. The authors would like to thank Giresun University for its financial support (Project No: FEN-BAP-A-220413-54).

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