Results of heavy metals and other water quality levels in tap water from Çan sourced from Ağı Dağı (Mt. Ağı) (Çanakkale, Turkey)

Gamze Kilinc, Selehattin Yilmaz, Muhammet Turkoglu and Huseyin Erdugan

ABSTRACT

In this study, the concentrations of heavy metals Pb, Cu, Zn, Cd, Ni, Fe, Mn and Cr were determined using an inductively coupled plasma and optical emission spectrophotometer (ICP-OES), and water quality parameters pH, temperature, and conductivity were measured using the YSI 556 MPS water probe. The water samples were collected monthly from five different street tap water points sourced from Mt. Agi (Ağı Dağı in Turkish) spring waters between May 2012 and February 2013 in Çan (Canakkale, Turkey). All results were compared with the drinking water standards of the Turkish Standards Institute (TSE 266), World Health Organization, European Union and US Environmental Protection Agency. While concentrations of Cu, Zn, Fe, and Mn were within limit values, Pb, Cd, Ni, and Cr were at undetectable limits. The highest concentrations of Cu, Zn, Fe, and Mn were 0.010 ppm, 0.018 ppm, 0.058 ppm, and 0.014 ppm, respectively. The findings revealed that although there was no public health risk in view of heavy metal concentrations, there was an acidity problem due to lower pH levels correlated with some heavy metals such as Cu ($R = 0.419$), Fe ($R = -0.421$) and Mn ($R = -0.687$).

Key words | Çanakkale, heavy metal, ICP-OES, Mount Agi, Turkey, water quality

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INTRODUCTION

On the one hand, water is an essential part of life and vital for all animals and plants. On the other hand, important water pollution problems threaten human health. Moreover, depletion of clean freshwater habitats together with increasing water pollution causes major environmental and human health problems. Therefore, water pollution has become a question of considerable public and scientific concern in the light of evidence of toxicity to human health. Due to rapid population growth in recent years and rapid development of industrialization and unplanned urbanization, natural surface and groundwaters have been greatly polluted, and so the need for safe and clean water has dramatically increased. It is known that access to healthy drinking water is essential to human health. Each person in the world requires at least 20–50 liters of healthy water a day for drinking, cooking and showering. Drinking water comes from a variety of sources including public water systems, spring water, private wells, or bottled water. Ensuring safe and healthy drinking water may be as simple as turning on the tap from a controlled public water system. Other water sources may need a water filter, water fluoridation check, or official check to ensure contamination from septic tanks is not too close to a private well. It is important to know where drinking water comes from, how it has been treated, and if it is safe to drink. Local geological and geographical conditions affecting groundwater may increase levels of various metal ions, often rendering the water 'soft' or 'hard'. Tap water remains susceptible to biological or chemical contamination (WHO 2011; Kır & Tumantozlu 2012). Heavy metals are one of the

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most important causes of water pollution. They are inorganic pollutants and accumulate in aquatic systems. Some have toxic and carcinogenic properties (Turkoglu *et al.* 1992; Kahraman *et al.* 2012). Heavy metals such as arsenic, cadmium, chromium, lead, mercury and selenium have toxic effects on the human body (Demir 2013). They create some problems for water pollution and biological systems (Turkoglu *et al.* 1992; Turkoglu & Parlak 1999; Suren *et al.* 2007; Kahraman *et al.* 2012).

In Turkey, one of the major problems is the inability to provide an adequate amount of drinking water (Uyak 2012; Demir 2013). Waters in some local regions of Turkey contain high concentrations of heavy metals (Yayıntas *et al.* 2007a, 2007b; Kahraman *et al.* 2012). Waters used for industry and agriculture, fertilizers, radioactive waste, fossil fuels, mining and other anthropogenic sources are effective in distributing metals into the environment (Turkoglu *et al.* 1992; Balci & Turkoglu 1993; Atalay & Pulatsu 2000; Koleli & Kantar 2005). Although there are many studies on heavy metal concentration in drinking waters in the world (Chakrabarty & Prasad 2011; Farahmand *et al.* 2011; Wongsasuluk *et al.* 2014), there are few studies on heavy metal concentrations and other water quality parameters in Turkey (Suren *et al.* 2007; Coskun *et al.* 2012; Demir 2013). Waters are contaminated by organic, inorganic, biological and thermal pollution sources in Turkey. Industrial waste is problematic in terms of waste composition due to synthetics, as well as the amount and type of contaminants. Discharge of copper, zinc, chromium, nickel, and cadmium into main drinking water sources such as rivers and lakes create a danger to public health (Toroglu *et al.* 2006; Yayintas *et al.* 2007a, 2007b; Kahraman *et al.* 2012). High variations in temperature, conductivity and pH are other important physicochemical parameters for public health. For instance, groundwater usually exhibits acidic properties. Surface waters usually have higher values of about pH 8 and possess basic characteristics. It is known that a pH between 6.50 and 8.50 is appropriate for drinking water. The pH of groundwater depends on the balance between dissolved carbon dioxide and other carbonate and bicarbonate compounds. This balance easily changes according to variations in temperature and pressure (Guler 1997). Conductivity is an essential parameter used to determine the ion concentrations in water. The level of conductivity depends on the temperature and salinity (Guler 1997). According to our literature investigation, only one study about heavy metal concentrations and biological parameters in tap water in Canakkale (Turkey) has been published (Coskun *et al.* 2012), but the concentrations of heavy metals connected with physicochemical parameters such as pH, temperature and conductivity have not been studied using inductively coupled plasma and optical emission spectrophotometer (ICP-OES) techniques in tap water from Çan.

Over the past few decades, human health protection from chemical contaminants in drinking water has been accomplished by developing chemical-specific standards (WHO 2011; EPA 2012). However, this approach alone is not feasible to address current issues, such as the occurrence of multiple contaminants in drinking water, for some of which there is little information about health effects, and water scarcity. Moreover, we still do not know the levels of heavy metal concentrations in drinking waters in undeveloped and in developing countries, such as Turkey. Therefore, concentrations of lead (Pb), copper (Cu), zinc (Zn), cadmium (Cd), nickel (Ni), iron (Fe), manganese (Mn) and chrome (Cr) together with other water quality parameters such as pH, conductivity and temperature were investigated in the tap waters of Çan sourced from Ağı Dağı (Çanakkale, Turkey).

MATERIAL AND METHODS

Study area and sampling stations

Çan, the study area, is a county in Çanakkale province and is geographically located east of Çanakkale, Turkey. It is surrounded by other counties such as Biga and Lapseki to the north, Yenice to the east, and Bayramiç to the south. Its population is about 50,000. Ağı Dağı is a part of the Kaz Dağı (Mt. Ida) mountains and is located about 50 km southeast of Canakkale on the Biga Peninsula, Northwestern Turkey.

Ağı Dağı spring water firstly comes to the reservoir through the water main and then it is freely available to the public from 120 different drinking fountains in Çan. In the study, water samples for analysis were collected monthly from five different points (public drinking fountains) between May 2012 and February 2013 (Figure 1). The water samples were placed in polyethylene bottles

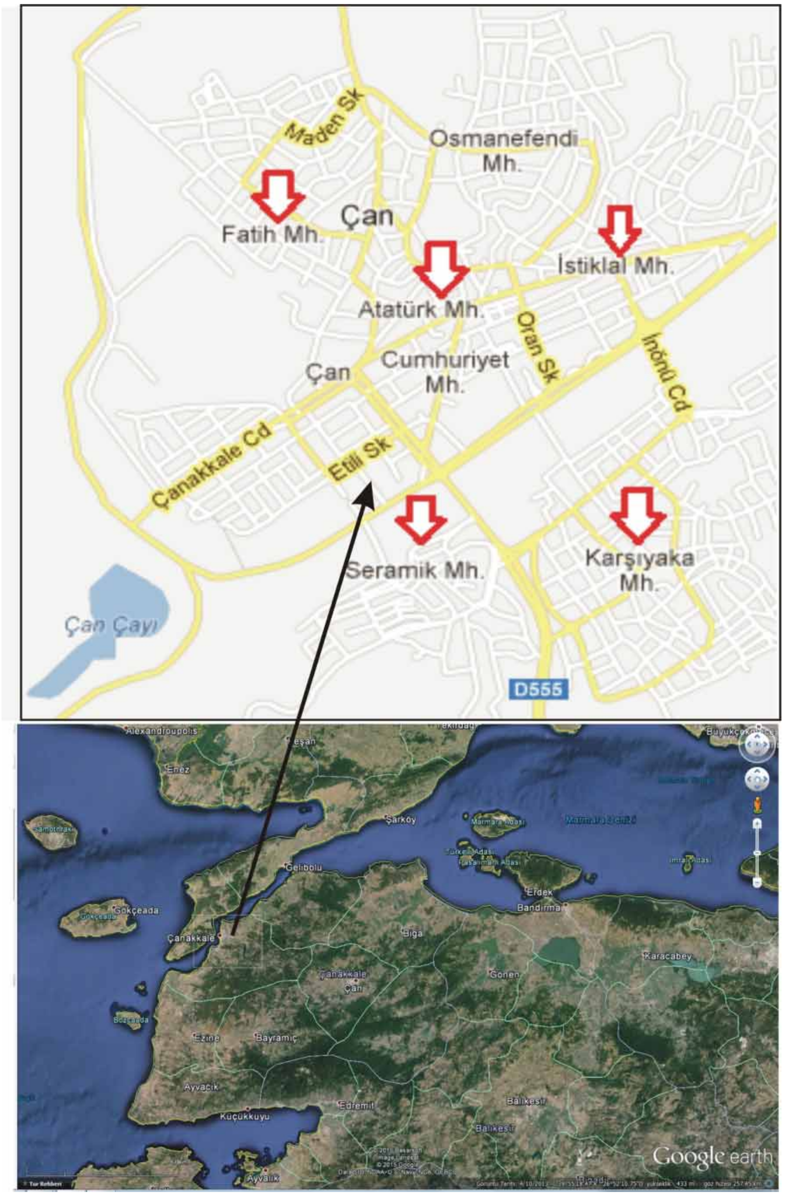

Figure 1 | Area of study with location of sampling stations.

(500 mL) and immediately transported to the laboratory. After pH and conductivity measurements, 3.00 mL concentrated HNO_3 was added to each bottle and stored in the deep freeze at –20.0 °C.

Chemicals

All reagents used were of analytical grade (Merck, Germany). Double distilled deionized water was used throughout all the experiments. Stock standard solution was prepared daily by appropriate dilution of AccuTrace, the reference Standard Merck 1.09492.0100 multi element standard solution, in double-distilled deionized water with 1–3 drops concentrated nitric acid. This solution was appropriately diluted with double-distilled deionized water for standard calibration solution of metals. Also, blanks were prepared with double-distilled deionized water containing 1–3 drops of concentrated nitric acid.

Metal analysis using the ICP-OES method

Spectroscopic determinations of Zn, Fe, Mn, Cu, Ni, Pb, Cd, and Cr in tap waters were completed using a Perkin Elmer Optima 8000 Model inductively coupled plasma and optic emission spectrophotometer (ICP-OES) at the Central Laboratory of Canakkale Onsekiz Mart University. All samples were analyzed three times.

Measurement of water quality parameters

Water quality parameters, except heavy metals, were measured by the YSI 556 MPS water probe *in situ*. Moreover, pH and conductivity were also measured using a Hach apparatus HQ40D model portable multi meter pHC301 model electrode and Hach HQ40D apparatus CDC401 model conductivity electrode, respectively, in the laboratory.

Statistical analysis

Two-way analysis of variance (ANOVA) was used to test the significance of differences between sampling points and seasons (two factors) at 0.01 and 0.05 levels in view of heavy metal concentrations and other water quality parameters. Pearson correlation analysis was used to examine the inter-relationships between heavy metal concentrations and other water quality parameters. Data calculations and statistical analysis were completed using SPSS 19.0.

RESULTS AND DISCUSSION

Seasonal variations of heavy metal concentration

Seasonal distributions of heavy metal (Pb, Cu, Zn, Cd, Ni, Fe, Mn, Cr) concentrations in the street tap water from Agi Dağı are presented in Table 1. Correlation and regression results of

Table 1 | The seasonal variations of heavy metal concentrations (mg L^{-1}) in the street tap waters of Çan sourced in Ağı Dağı, Çanakkale, Turkey

Seasons	Sampling station	Cu	Zn	Fe	Mn	Ni	Cd	Cr	Pb
Winter	Atatürk District	0.003	0.011	0.030	0.010	0.000	0.000	0.000	0.000
	Seramik District	0.007	0.000	0.029	0.009	0.000	0.000	0.000	0.000
	Karsiyaka District	0.005	0.011	0.035	0.009	0.000	0.000	0.000	0.000
	Fatih District	0.005	0.011	0.019	0.009	0.000	0.000	0.000	0.000
	Istiklal District	0.003	0.000	0.027	0.009	0.000	0.000	0.000	0.000
	Winter average	**0.005 ± 0.002**	**0.007 ± 0.006**	**0.028 ± 0.006**	**0.009 ± 0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Spring	Atatürk District	0.000	0.007	0.045	0.014	0.000	0.000	0.000	0.000
	Seramik District	0.000	0.000	0.043	0.014	0.000	0.000	0.000	0.000
	Karsiyaka District	0.000	0.013	0.058	0.013	0.000	0.000	0.000	0.000
	Fatih District	0.000	0.007	0.045	0.012	0.000	0.000	0.000	0.000
	Istiklal District	0.000	0.000	0.054	0.014	0.000	0.000	0.000	0.000
	Spring average	**0.000**	**0.005 ± 0.006**	**0.049 ± 0.007**	**0.013 ± 0.001**	**0.000**	**0.000**	**0.000**	**0.000**
Summer	Atatürk District	0.000	0.001	0.027	0.010	0.000	0.000	0.000	0.000
	Seramik District	0.000	0.012	0.023	0.010	0.000	0.000	0.000	0.000
	Karsiyaka District	0.000	0.008	0.011	0.010	0.000	0.000	0.000	0.000
	Fatih District	0.000	0.013	0.030	0.011	0.000	0.000	0.000	0.000
	Istiklal District	0.010	0.014	0.034	0.010	0.000	0.000	0.000	0.000
	Summer average	**0.002 ± 0.004**	**0.010 ± 0.005**	**0.025 ± 0.009**	**0.010 ± 0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Autumn	Atatürk District	0.002	0.002	0.004	0.009	0.000	0.000	0.000	0.000
	Seramik District	0.002	0.018	0.000	0.010	0.000	0.000	0.000	0.000
	Karsiyaka District	0.001	0.004	0.001	0.010	0.000	0.000	0.000	0.000
	Fatih District	0.000	0.009	0.005	0.010	0.000	0.000	0.000	0.000
	Istiklal District	0.000	0.002	0.002	0.010	0.000	0.000	0.000	0.000
	Autumn average	**0.001 ± 0.001**	**0.007 ± 0.007**	**0.002 ± 0.002**	**0.010 ± 0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	Annual average	**0.002 ± 0.003**	**0.007 ± 0.006**	**0.026 ± 0.018**	**0.011 ± 0.002**	**0.000**	**0.000**	**0.000**	**0.000**

heavy metals and other water quality parameters are given in Table 2 and Figures 2 and 3. The current heavy metal results are compared with the limit values of Turkish Standard-TS266 (TSE 2005), European Union (EU 1998) and World Health Organization (WHO 2011) and US Environmental Protection Agency (EPA 2012) in Table 3.

The results in Table 1 show that all heavy metal concentrations were under the limit values of the Turkish Standard-TS266 (TSE 2005), European Union (EU 1998), World Health Organization (WHO 2011) and US Environmental Protection Agency (EPA 2012). Seasonal variations of heavy metal concentrations revealed that the autumn period had the lowest values except for Mn. Mn concentrations were similar during the whole sampling period. Iron concentrations were highest in the spring period compared with other seasons. In view of Cu concentrations, although the highest concentration level (0.010 mg L^{-1}) was measured in the summer period in tap water from the Istiklal District, the concentrations of the metal during the winter period were higher than any other season at all sampling stations. The highest Zn concentration (0.018 mg L^{-1}) was measured in tap water from Seramic District in the autumn period. In view of Fe concentration, the highest value (0.058 mg L^{-1}) was found in tap water from the Karsiyaka District in the spring period. The tap water from Ataturk, Seramik and Istiklal Districts had the highest Mn concentrations (0.014 mg L^{-1}) in the spring period (Table 1). However, both regional and seasonal differences were insignificant according to the ANOVA statistical analysis ($P \leq 0.05$).

The probable cause of high heavy metal levels in spring and winter periods, compared to autumn and summer periods, is that Ağı Dağı has high rainfall in the winter and spring with the lowest rainfall in summer and autumn. It is possible that rain water and other inputs to the Ağı

Table 2 | Correlation results between heavy metals and other water quality parameters in the street tap waters of Çan sourced from Ağı Dağı, Çanakkale, Turkey

	pH	Temp	Con	Zn	Fe	Mn	Cu
pH	1	*	*	*	*	*	*
Temp	0.0877	1	*	*	*	*	*
Con	–0.0042	**0.9638**	1	*	*	*	*
Zn	0.0315	0.2681	0.2414	1	*	*	*
Fe	**–0.4205**	–0.31	–0.2683	–0.0551	1	*	*
Mn	**–0.6867**	–0.0295	–0.022	–0.1214	**0.6843**	1	*
Cu	**0.4192**	–0.2287	–0.2459	0.1805	0.0012	**–0.4921**	1

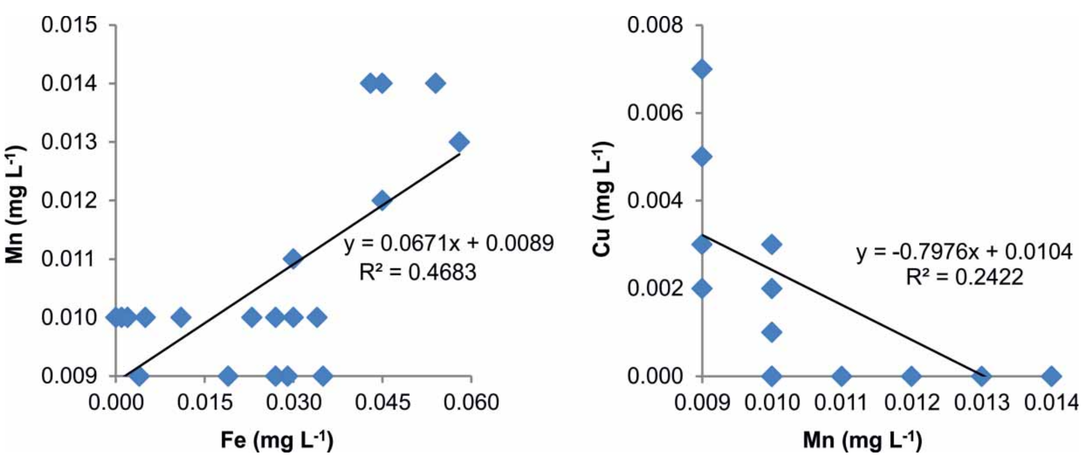

Figure 2 | Relationships between Mn and Fe and between Mn and Cu in the street tap waters of Çan sourced from Ağı Dağı, Çanakkale, Turkey. The coefficients of determination (R^2) and the equation (y) are shown for each regression.

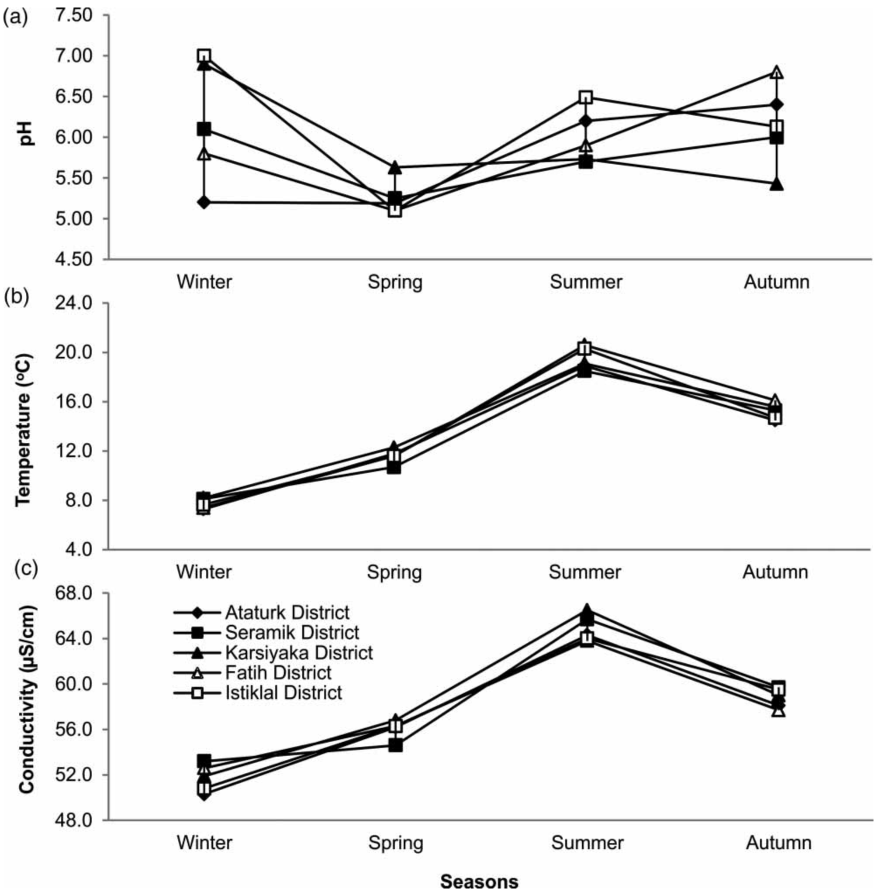

Figure 3 | Seasonal variations of pH (a), temperature (b), conductivity (c) in the street tap waters of Çan sourced from Ağı Dağı, Çanakkale, Turkey.

Table 3 | Annual average concentrations of heavy metals (mg L^{-1}) compared with drinking water standard limit values of TS266 standard (Turkish Standard Institute), EU, WHO and US EPA

Heavy metal	Annual average (current study)	TSE	EU	WHO	EPA
Zn	0.009	5.00	–	–	5.00
Fe	0.026	0.20	0.20	–	0.30
Mn	0.011	0.05	0.05	0.05	0.05
Cu	0.006	3.00	2.00	–	1.00
Ni	0.000	20.0	–	–	–
Cd	0.000	0.05	0.05	0.05	0.05
Cr	0.000	0.05	0.05	0.05	0.05
Pb	0.000	0.05	0.05	0.05	0.05

Dağı area, which is the main source of street tap waters in Çan, carries materials rich in heavy metals such as Fe, Zn and Cu. When relationships between various metal concentrations are examined, relationships between Mn and Fe ($R = 0.684$), and between Mn and Cu ($R = –0.492$) were more significant than between any other metals. In other words, while there was linear regression between Mn and Fe ($R = 0.468$), there was nonlinear regression between Mn and Cu ($R = –0.242$) (Table 2 and Figure 2).

According to the drinking standard limits of the Turkish Standards (TS 266), WHO, EU and US EPA, while concentrations of Cu, Zn, Fe, and Mn were within allowed limit values, the concentrations of Pb, Cd, Ni, and Cr were below the limits. The findings revealed that there is no public health risk in terms of heavy metal concentrations in the street tap waters of Çan sourced from Ağı Dağı.

Seasonal variations of water quality parameters

Seasonal variations of water quality parameters such as pH, temperature and conductivity in the street tap water are presented in Table 4 and Figure 3. Correlation and regression

Table 4 | Seasonal variations of water quality parameters in the street tap waters of Çan sourced from Ağı Dağı, Çanakkale, Turkey

Season	Sampling station	pH	Temperature (°C)	Conductivity (μS/cm)
Winter	Ataturk District	5.20 ± 0.54	7.30 ± 0.53	50.3 ± 0.82
	Seramik District	6.10 ± 0.21	8.11 ± 1.28	53.2 ± 0.61
	Karsiyaka District	6.90 ± 0.18	8.20 ± 0.61	51.9 ± 0.91
	Fatih District	5.80 ± 0.19	7.40 ± 0.61	52.6 ± 0.76
	Istiklal District	7.00 ± 0.19	7.65 ± 0.92	50.8 ± 0.47
	Average (Winter)	**6.20 ± 0.76**	**7.73 ± 0.41**	**51.8 ± 1.21**
Spring	Ataturk District	5.19 ± 0.04	11.8 ± 1.57	56.2 ± 0.87
	Seramik District	5.25 ± 0.29	10.7 ± 0.92	54.6 ± 1.66
	Karsiyaka District	5.63 ± 0.58	12.3 ± 0.87	56.8 ± 1.76
	Fatih District	5.10 ± 0.06	11.6 ± 0.53	56.3 ± 0.20
	Istiklal District	5.10 ± 0.13	11.6 ± 0.61	56.3 ± 0.63
	Average (Spring)	**5.25 ± 0.22**	**11.6 ± 0.58**	**56.0 ± 0.84**
Summer	Ataturk District	6.20 ± 0.30	18.9 ± 0.35	64.3 ± 0.10
	Seramik District	5.70 ± 0.44	18.5 ± 0.17	65.7 ± 0.20
	Karsiyaka District	5.73 ± 0.06	19.1 ± 0.36	66.5 ± 0.82
	Fatih District	5.90 ± 0.04	20.6 ± 0.97	63.8 ± 0.36
	Istiklal District	6.49 ± 0.64	20.3 ± 0.20	64.0 ± 0.10
	Average (Summer)	**6.00 ± 0.34**	**19.5 ± 0.92**	**64.9 ± 1.18**
Autumn	Ataturk District	6.40 ± 0. 54	14.5 ± 0.53	58.1 ± 0.82
	Seramik District	6.00 ± 0.21	15.3 ± 1.28	59.7 ± 0.61
	Karsiyaka District	5.43 ± 0.18	15.6 ± 0.61	59.0 ± 0.91
	Fatih District	6.80 ± 0.19	16.1 ± 0.61	57.7 ± 0.76
	Istiklal District	6.13 ± 0.19	14.7 ± 0.92	59.5 ± 0.47
	Average (Autumn)	**6.15 ± 0.51**	**15.2 ± 0.65**	**58.8 ± 0.87**
Annual average		**5.90 ± 0.60**	**13.5 ± 4.50**	**57.9 ± 4.97**

results between heavy metals and water quality parameters are displayed in Table 5 and Figure 4. The current values of water quality parameters such as pH, temperature and conductivity were compared with the standard limit values of the Turkish Standard-TS266 (TSE 2005), European Union (EU 1998), World Health Organization (WHO 2011) and US Environmental Protection Agency (EPA 2012) and are shown in Table 5.

Annual values of pH, temperature, and salinity varied between 5.10 and 7.00 (average: 5.90 ± 0.60), 7.30 and 20.6 °C (average: 13.5 ± 4.50 °C), and 50.3 and 66.5 μS cm^{-1} (average: 57.9 ± 4.97 μS cm^{-1}), respectively (Table 4). Variations in pH at all sampling stations during the year were higher than temperature and conductivity (Figure 3). The regional variation in the pH levels was significant according to ANOVA statistical analysis ($P \geq 0.05$). There was an increase in temperature and conductivity from winter to summer periods, and both revealed a fairly similar distribution during the year. The distributions were supported by positive correlation ($R = 0.964$) and linear regression ($R = 0.929$) (Table 2 and Figure 4). Moreover, relationships between pH and heavy metals were more significant than those with temperature and conductivity. For instance, while the regressions between pH and Mn and between pH and Fe were nonlinear, the regression between pH and Cu was linear (Figure 4). The

Table 5 | Annual average results of some water quality parameters compared with drinking water standard limit values of TS266 standard (Turkish Standard Institute), EU, WHO (World Health Organization) and US EPA

Water quality parameters	Annual average (current study)	TSE 266	EU	WHO	EPA
Temperature (°C)	13.40	12.0–25.0	–	–	–
pH	5.890	6.50–9.50	6.50–9.50	6.50–8.50	6.50–8.50
Conductivity(μScm^{-1})	57.90	650–2,500	–	–	–

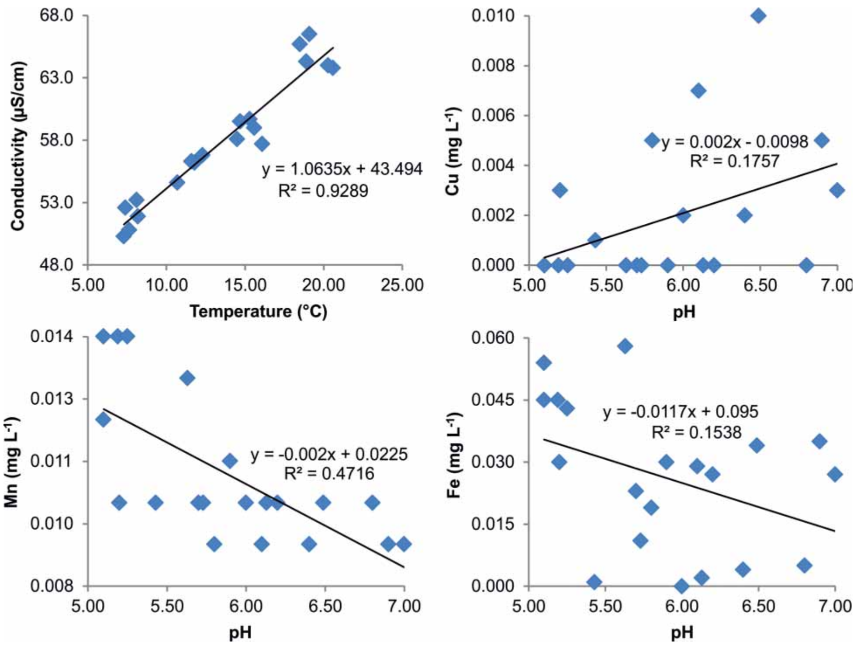

Figure 4 | Relationships between temperature and conductivity and relationships between various metals in the street tap waters of Çan sourced from Ağı Dağı, Çanakkale, Turkey. The coefficients of determination (R^2) and the equation (y) are shown for each regression.

findings revealed an important relationship between pH and heavy metal accumulation in aquatic systems.

While temperature and conductivity values were within limit values allowed by Turkish Standards (TS 266), WHO, EU and US EPA, current pH values were lower (more acidic) than the limit values of these organizations. Findings from pH revealed that there was a public health risk due to high acidity in the street tap waters of Çan sourced from Ağı Dağı (Table 5). It is known that optimum pH will vary in different supplies according to the composition of the water and the nature of the construction materials used in the distribution system. Extreme pH values can result from accidental spills, treatment breakdowns, and insufficiently cured cement mortar pipe linings (APHA 1998).

CONCLUSIONS

The results of the study indicate that, except for pH, heavy metal concentrations and other quality parameters were compatible with the limits of the Turkish Standard-TS266 (TSE 2005), European Union (EU 1998), World Health Organization (WHO 2011) and US Environmental Protection Agency (EPA 2012). Therefore, while there was no public health risk in view of heavy metal concentrations (Cd, Cu, Cr, Fe, Mn, Ni, Pb, and Zn), unfortunately there is a risk considering the lower pH levels or higher acidity (min–max: 5.10–7.00; average: 5.90 ± 0.60) in the street tap waters sourced from Ağı Dağı in Çan. It is known that although pH usually has no direct impact on water consumers, it is one of the most important operational water quality parameters, and levels in most natural waters vary between 6.50 and 8.50 (APHA 1998). The pH of natural water is a measure of the acid–base equilibrium and is controlled by the carbon dioxide–bicarbonate–carbonate equilibrium system. Therefore, an increase in CO_2 causes lower pH levels, whereas a decrease in CO_2 causes higher pH levels. Moreover, temperature will affect the equilibrium and the pH. For example, in pure water, a decrease in pH of about 0.45 occurs as the temperature is raised by 25 °C. In water with a buffering capacity due to carbonate, bicarbonate, and hydroxyl ions, this temperature effect is modified. Therefore, temperature is also important for drinking water, and high temperature in water can increase acidity, which easily increases the solubility of metals (APHA 1998). The relationship of pH with other water quality parameters such as heavy metals is of major importance in determining the corrosion ability of the water. In general, a lower pH in water indicates higher corrosion. However, pH is only one of a variety of factors affecting corrosion (Langelier 1946; McClanahan & Mancy 1974; Nordberg et al. 1985; Murrel 1987; Stone et al. 1987; Webber et al. 1989).

Exposure to radical pH levels causes irritation in the eyes, skin, and mucous membranes. Below pH 4.00, redness and irritation of the eyes is reported. Below pH 2.50, damage to the epithelium is irreversible and extensive (APHA 1998). Exposure to high pH values can also result in similar effects. Eye irritation and inflammation of skin are associated with pH values greater than 11. In addition, solutions with pH 10–12.5 are reported to cause hair fibers to swell (WHO 1986). In sensitive and allergic individuals, gastrointestinal irritation may also occur. In addition, because pH can affect the degree of corrosion of metals as well as disinfection efficiency, it may have an indirect effect on human health. Waters with high acidity or low pH accumulate more toxic heavy metals and create a more dangerous situation in terms of public health (WHO 1986). In this study, correlation and regression results revealed that pH was nearly connected with some heavy metals such as Fe ($R = -421$), Mn ($R = -687$) and Cu ($R = 419$). However, pH did not have any relationship with temperature and conductivity.

The pH of the water entering the distribution system must be controlled to minimize the corrosion of water mains and pipes in street and household water systems. Lack of regard for this may result in the contamination of drinking water and in adverse effects on its appearance, taste, and odor. Therefore, water in the water main and pipe systems should be frequently cleaned and suitable chemicals used to raise pH if it is dangerous for human health. It is known that there are kidney problems among inhabitants where street tap waters are used as drinking water in Çan. However, there is a need to measure more water quality parameters in drinking water and to monitor kidney activities and blood parameters of inhabitants using these drinking waters in order to say more about public health.

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