

Forest fire impacts on water quality: Taşköprü case

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Abstract: Wildfires can significantly influence surface water quality by altering soil structure, vegetation cover, and hydrological processes. This study examines the physicochemical effects of a surface and crown fire that occurred in 2020 within a 1,508-hectare pure black pine (*Pinus nigra* Arnold) forest in the Taşköprü district of Kastamonu, Türkiye, on stream water quality. Over a 12-month monitoring period, water samples were collected biweekly from both fire-affected and control streams. Key water quality parameters were analyzed. The results revealed statistically significant differences in pH, electrical conductivity (EC), total dissolved solids (TDS), and turbidity between the two sites ($p < 0.05$), while DO did not differ significantly. Notably, turbidity was markedly higher in the fire-affected site (9.48 NTU) compared to the control site (5.23 NTU). Conversely, EC and TDS values were lower in the fire-affected stream (211.7 $\mu\text{S}/\text{cm}$ and 105.9 mg/L, respectively) than in the control stream (255.3 $\mu\text{S}/\text{cm}$ and 127.7 mg/L). A very strong positive correlation was found between EC and TDS ($r > 0.98$) at both sites, while significant positive correlations were also observed between pH and EC/TDS in the fire-affected stream. The increase in turbidity and shifts in solute concentrations indicate that wildfire-induced vegetation loss and surface runoff contributed to sediment and nutrient loading. These findings underscore the importance of water and land management practices in post-wildfire conditions and contribute to the existing literature on fire-induced changes in water quality in Türkiye.

Keywords: Hydrology, Türkiye, Wildfire, Water quality, Water resources

Orman yangınlarının su kalitesi üzerindeki etkileri: Taşköprü örneği

Öz: Orman yangınları, toprak yapısını, bitki örtüsünü ve hidrolojik süreçleri değiştirerek yüzey suyu kalitesini önemli ölçüde etkileyebilir. Bu çalışma, 2020 yılında Türkiye'nin Kastamonu ili Taşköprü ilçesinde, 1508 hektarlık saf karaçam (*Pinus nigra* Arnold) ormanında meydana gelen yüzey yangını ve tepe yangınının dere suyu kalitesi üzerindeki fiziko-kimyasal etkilerini incelemektedir. On iki aylık izleme süresi boyunca, yangından etkilenmiş ve kontrol niteliğindeki akarsulardan iki haftada bir su örnekleri toplanmıştır. Temel su kalite parametreleri analiz edilmiştir. Elde edilen sonuçlar, pH, elektriksel iletkenlik (EC), toplam çözünmüş katılar (TDS) ve bulanıklık parametrelerinde iki istasyon arasında istatistiksel olarak anlamlı farklılıklar olduğunu göstermiştir ($p < 0,05$); çözünmüş oksijen (DO) açısından ise anlamlı bir fark gözlenmemiştir. Özellikle bulanıklık değeri yangın alanında 9.48 NTU ile kontrol alanındaki 5.23 NTU'ya kıyasla belirgin biçimde yüksek bulunmuştur. Buna karşılık, yangın alanında EC ve TDS ortalamaları sırasıyla 211,7 $\mu\text{S}/\text{cm}$ ve 105,9 mg/L iken, kontrol alanında bu değerler 255,3 $\mu\text{S}/\text{cm}$ ve 127,7 mg/L olarak ölçülmüştür. Her iki istasyonda da EC ile TDS arasında çok güçlü pozitif korelasyonlar ($r > 0,98$) belirlenmiş, ayrıca yangından etkilenen alanda pH ile EC/TDS arasında da anlamlı pozitif ilişkiler saptanmıştır. Bulanıklık değerlerindeki artış ve çözünen madde konsantrasyonlarındaki değişim, yangın sonrası bitki örtüsü kaybı ve yüzey akışı kaynaklı sediment ve besin maddesi yüklemesini işaret etmektedir. Bu bulgular, yangın sonrası koşullarda su ve arazi yönetimi uygulamalarının önemini vurgulamakta ve Türkiye'de yangın kaynaklı su kalitesi değişimleri konusundaki literatüre katkı sağlamaktadır.

Anahtar kelimeler: Hidroloji, Türkiye, Orman yangını, Su kalitesi, Su kaynakları

1. Introduction

Surface water resources, such as lakes and rivers, are critical in meeting drinking water demands and sustaining ecosystems across many regions. Climate change, human activities, and forest fires have a direct impact on these resources (Delpla et al., 2009; Emin and Mutlu, 2024). Climate change not only reduces water availability but also deteriorates water quality (Leveque et al., 2021; Ma et al., 2022; Kutlu and Mutlu, 2024). Prolonged droughts, driven by rising temperatures and decreasing precipitation, have significantly contributed to the escalation of wildfires. These wildfires, which tend to occur more frequently and spread rapidly, have caused widespread forest destruction. (Fernandez-Garcia et al., 2020; Arianoutsou et al., 2024;

Turiel-Santos et al., 2025). Due to climate change, wildfire seasons are expected to intensify, increase in frequency, and last longer (Westerling et al., 2006; Cui et al., 2020; Zhang et al., 2021). According to the Intergovernmental Panel on Climate Change (IPCC), by 2030, heatwaves and wildfires are projected to become increasingly prevalent climate-related threats (IPCC, 2013).

Türkiye has experienced rising temperatures and declining precipitation in line with climate change. In 2024, the national average temperature was 15.6°C—1.7°C above the 1991–2020 average—while annual precipitation decreased by 6.3% (MGM, 2024). These trends are expected to continue, with projected temperature increases of 2–6°C in the coming decades (Önol et al., 2014; Demirçan et al., 2017; Türkeş et al., 2020). The combined effects of rising

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Received (Geliş tarihi): 16.06.2025, Accepted (Kabul tarihi): 01.09.2025



Citation (Atıf): Çiloğlu, S., Güneş Şen, S., 2025. Forest fire impacts on water quality: Taşköprü case. Turkish Journal of Forestry, 26(3): 342-352. DOI: [10.18182/tjf.1720459](https://doi.org/10.18182/tjf.1720459)

temperatures and declining precipitation have led to a significant increase in forest fires throughout Türkiye. Between 2014 and 2023, forest fires destroyed over 221,000 hectares of forest land (OGM, 2023). These escalating fire risks, driven by global warming, pose serious threats to human communities and forest ecosystems (Westerling et al., 2006). Fires represent a major threat to forest sustainability, reducing forest coverage and disrupting ecological functions (Eraslan, 1973; Doğanay and Doğanay, 2004; Küçük and Aktepe, 2017). Forest fires adversely affect various forest functions, including the hydrological cycle, recreation, erosion prevention, aesthetics, national defense, public health, and forest product provisioning (Küçükosmanoğlu, 1995; Moya et al., 2007; Küçük and Bilgili, 2010; Forbes et al., 2011; Ekhuemelo et al., 2016; Trenčiansky et al., 2021). During wildfires, pollutants such as mercury (Hg), nitrogen oxides (NOx), sulfur oxides (SOx), carbon oxides (COx), and polycyclic aromatic hydrocarbons (PAHs) are released into the atmosphere (Campos et al., 2019; Mansilha et al., 2019; Hagi et al., 2020; Gorshkov et al., 2021). These pollutants can accumulate in the environment, particularly in dry water bodies, while fire retardants rich in nutrients, used during both controlled burns and wildfire suppression efforts, can further degrade water quality (Richter et al., 1982; Crouch et al., 2006; O'Dell et al., 2020; Schneider et al., 2021; Paul et al., 2022). Wildfires significantly alter the physical, chemical, and biological characteristics of adjacent soils and water resources. Vegetation loss compromises soil stability and hydrological balance. Ash deposits form hydrophobic layers that increase runoff and reduce infiltration, thereby enhancing erosion and the transport of sediments and other contaminants into water bodies (Moody and Martin, 2001; Reneau et al., 2007; Sheridan et al., 2007a; Lane et al., 2008; Moody and Martin, 2009; Wilkinson et al., 2009; Smith et al., 2011; Ebel et al., 2012; Bodí et al., 2014; Hohner et al., 2019; Şen, 2024; Baç and Güneş Şen, 2025). Consequently, water quality deteriorates, and affected resources may become unsuitable for human consumption (White et al., 2006; Smith et al., 2011). Moreover, wildfires in forested watersheds impair the hydrological services provided by forests by destroying mature and regenerating forest cover. This degradation reduces natural water filtration and storage capacities, resulting in further pollution of water resources (Küçükosmanoğlu, 1995; Bladon et al., 2014; Teclé and Neary, 2015; Bilgin et al., 2016; Mutlu and Güzel, 2024).

In this context, the present study investigates the changes in stream water quality following a wildfire that burned 1,508 hectares of black pine forest in the Taşköprü district of Türkiye. Although numerous studies have explored the ecological consequences of wildfires, limited research has assessed long-term changes in water quality, especially in Türkiye. To address this gap, the study monitored five core water quality parameters—pH, EC, TDS, DO, and turbidity—over a one-year period in both fire-affected and control streams. This empirical evidence provides originality to the study, contributes to the literature on wildfire impacts, and supports future forest and water resource management policies.

2. Materials and methods

2.1. Study area

The study was conducted in the Taşköprü district of Kastamonu Province, located in the Western Black Sea Region of Türkiye (Figure 1). The researchers selected this area because of a large-scale surface and crown fire that occurred in 06.09.2020, which burned 1,508 hectares pure black pine (*Pinus nigra* Arnold) forest within the jurisdiction of the Taşköprü Forest Management Directorate. The study area is geographically located between 41°21'55" N latitude and 34°11'47" E longitude, with an average elevation of 1,054 meters above sea level (Baykalı and Şen, 2024; Pacaldo et al., 2024; 2025). The wildfire-affected area selected as the study site and the nearby control area share similar characteristics; as both consist of pure black pine (*Pinus nigra*) forests. The forest fire affected areas with an altitude of 1,140 to 1,400 meters and a slope of 40% in the south. According to data from the General Directorate of Meteorology, the Taşköprü Meteorological Station has recorded climatic observations since 2014. Based on the data collected between 2014 and 2024, the area experiences an average annual temperature of 11.9°C and an average annual precipitation of 474 mm. On the day of the wildfire, the air temperature was recorded as 36°C, and the relative humidity was 20% (MGM, 2024). According to the Köppen climate classification, the region falls under the Cfa category—humid subtropical climate—characterized by hot summers, mild winters, and precipitation throughout the year (Kottek, 2006; Bölük et al., 2023; Pacaldo et al., 2024, 2025).

2.2. Collection and analysis of water samples

The study aimed to assess the effects of a wildfire on water quality by comparing stream water from a wildfire-affected area with that from an unaffected control area. For this purpose, water sampling and analysis were conducted between May 2022 and April 2023. Wildfires can affect stream water quality not only in the immediate aftermath (short term) but also over the medium and long term through processes such as ash deposition, sediment transport, erosion, and delayed nutrient leaching. Several studies have demonstrated that alterations in water chemistry and sediment dynamics may persist for years following wildfire events (Smith et al., 2011; Burke et al., 2013; Sherson et al., 2015; Rust et al., 2018). Accordingly, the present study focuses on medium-term post-fire conditions rather than short-term impacts, offering insights into the persistence of wildfire effects. This approach enhances the understanding of the temporal dynamics of water quality in fire-affected forested catchments by elucidating the extent to which these impacts endure under natural recovery processes.

Water samples were collected at 15-day intervals over a 12-month period from two locations along a continuously flowing stream within the wildfire-affected area. However, due to heavy snowfall and unfavorable field conditions, access to the site was not possible in December 2022 and January, February, and March 2023; therefore, sampling was conducted once a month during these periods. As a result, a total of 40 water samples were obtained from the fire-affected stream throughout the study period. For comparison, an additional 40 water samples were collected from a stream located in a nearby unburned forest (control stream).

According to the Turkish Regulation on Water Pollution Control, water samples should be analyzed as soon as possible after collection. If analysis is to be performed within 24 hours, samples must be stored at a temperature of +4°C. Parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), and dissolved oxygen (DO) must be measured in situ. The allowable time between collection and analysis depends on the type of sample, the intended measurements, and storage conditions (Güneş Şen, 2015, 2021).

Accordingly, the research team conducted on-site measurements of pH, EC, TDS, and DO at the sampling locations. Turbidity measurements were performed in the

laboratory using collected samples transported under controlled conditions. All field measurements were carried out between 09:00 and 12:00 to minimize diurnal variation. Equipment calibration was performed according to the manufacturer’s specifications prior to each sampling.

Analytical details are as follows:

pH, EC, TDS, DO: In situ measurements were conducted using a Multi-Parameter Meter (AZ Instrument 86031 Combo).

Turbidity: Measurements were conducted in the laboratory using a digital Milwaukee Mi415 Turbidity Meter.

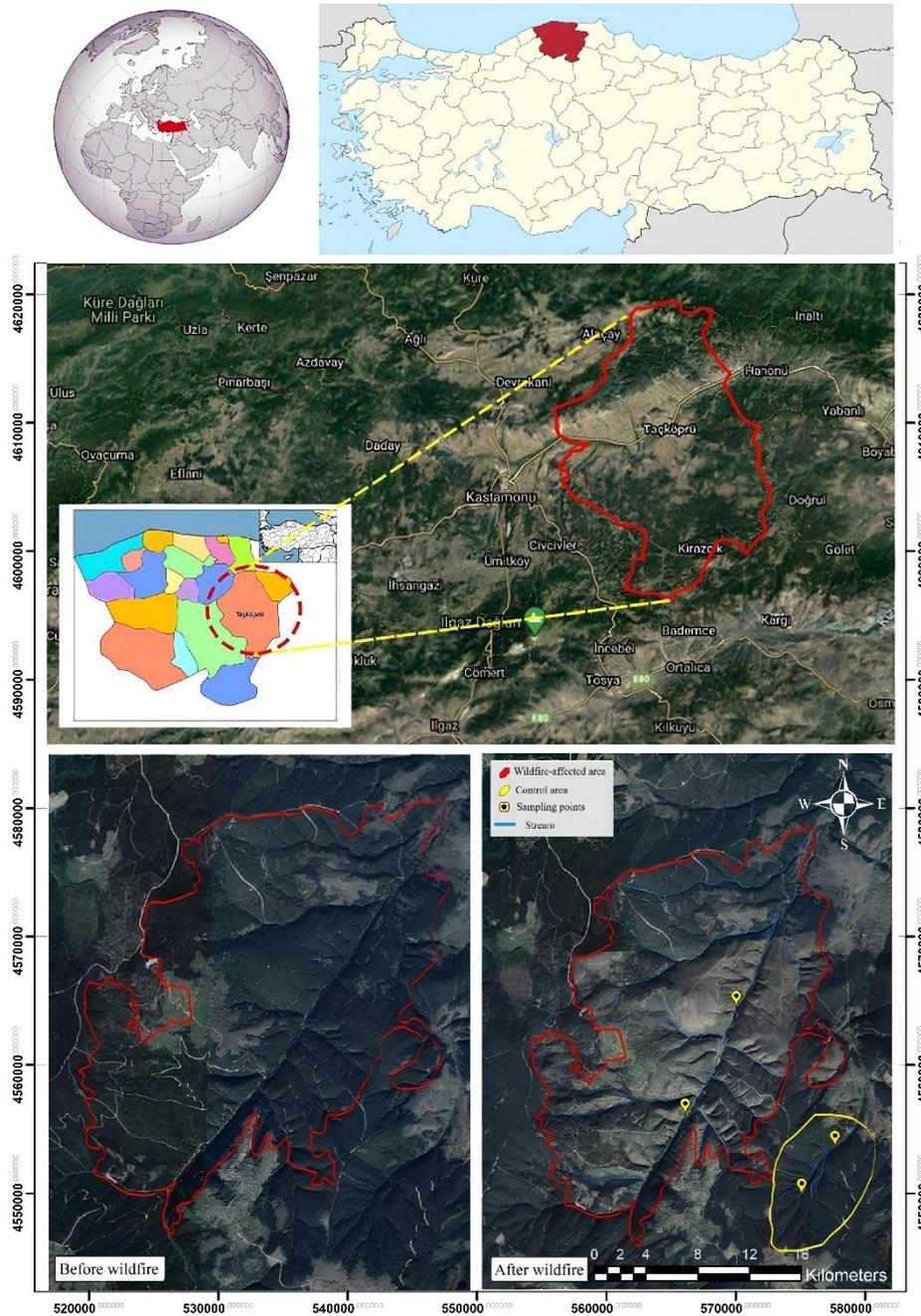


Figure 1. Geographical location of the study area

2.3. Statistical analyses

The normality of the data was evaluated using skewness and kurtosis values, with thresholds of ± 1.5 (Tabachnick and Fidell, 2013) and ± 2 (George and Mallery, 2010). For normally distributed data, the Independent Samples t-test was applied. For non-normally distributed data, the Mann-Whitney U test was used (Güngör and Şen, 2024). The t-test assesses statistically significant differences in means between two independent groups (Shapiro and Wilk, 1965; Arslan, 2024; Şen, 2025). The Mann-Whitney U test, a non-parametric alternative, compares the distributions of two independent groups when normality assumptions are violated (Spence et al., 1990).

To examine relationships between water quality parameters, Spearman's Rho correlation analysis was conducted. This non-parametric test assesses the strength and direction of associations between ranked variables (Fisher, 1915). A heatmap has been generated using the Seaborn and Matplotlib libraries to visualize the correlation coefficients.

This visualization facilitates the quantitative and visual assessment of the linear relationships among the variables. The color intensity has been adjusted to represent the magnitude and direction of the correlation coefficients.

3. Results

To evaluate the post-fire water quality changes, minimum, maximum, and average values of pH, EC, TDS, DO, and turbidity parameters were analyzed.

According to Table 1, in the wildfire-affected stream, the mean pH was 7.2, EC was 535.7 $\mu\text{S/cm}$, TDS was 268.1 mg/L, DO was 41.2 mg/L, and turbidity was 1.3 FNU. In the control stream, the mean pH was 7.1, EC was 550.3 $\mu\text{S/cm}$, TDS was 274.4 mg/L, DO was 40.9 mg/L, and turbidity was 1.2 FNU.

The pH values ranged from 6.9 to 7.6 in the wildfire-affected area and from 6.7 to 7.4 in the control area. EC ranged from 479 to 635 $\mu\text{S/cm}$ in the wildfire-affected area and from 501 to 593 $\mu\text{S/cm}$ in the control area (Figure 2).

Table 1. Minimum, maximum, and mean values of water quality parameters in wildfire-affected and control streams

Parameter	Area	N	Min	Max	Mean
pH	Wildfire-affected	40	6.9	7.6	7.2
	Control	40	6.7	7.4	7.1
EC ($\mu\text{S/cm}$)	Wildfire-affected	40	479	635	535.7
	Control	40	501	593	550.3
TDS (mg/L)	Wildfire-affected	40	241	317	268.1
	Control	40	226	297	274.4
DO (mg/L)	Wildfire-affected	40	37.8	44.6	41.2
	Control	40	34.2	46.6	40.9
Turbidity (FNU)	Wildfire-affected	40	1.0	1.9	1.3
	Control	40	0.6	1.8	1.2

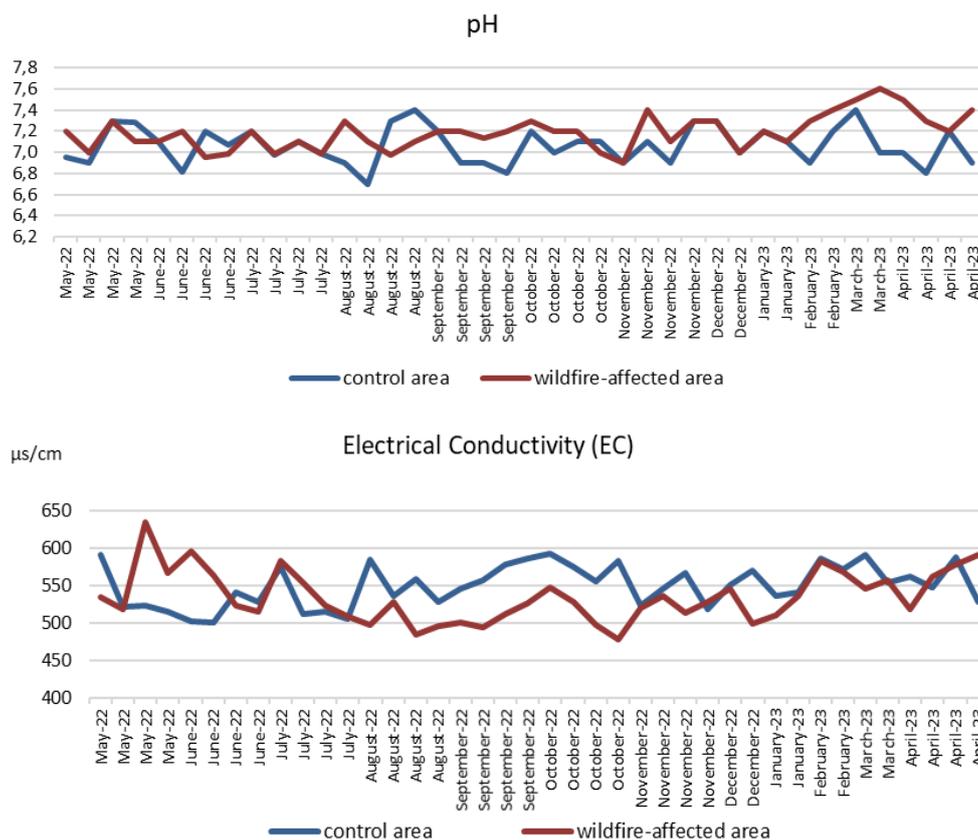


Figure 2. pH and EC measurements in the wildfire-affected and control areas

TDS values ranged from 241 to 317 mg/L in the wildfire-affected stream and from 226 to 297 mg/L in the control stream. DO ranged from 37.8 to 44.6 mg/L in the wildfire-affected stream and from 34.2 to 46.6 mg/L in the control stream (Figure 3).

Turbidity ranged from 1.0 to 1.9 FNU in the wildfire-affected stream and from 0.6 to 1.8 FNU in the control stream (Figure 4).

Statistical analysis revealed significant differences between the wildfire-affected and control streams in terms of

pH ($t = 3.230, p < 0.05$), EC ($t = -2.078, p < 0.05$), and turbidity ($t = 2.491, p < 0.05$). No significant difference was observed in DO ($p > 0.05$). The Mann–Whitney U test also indicated a significant difference in TDS between the two sites ($U = 576.5, p < 0.05$) (Tables 2 and 3). The higher turbidity in the wildfire-affected area suggests increased sediment transport resulting from vegetation loss and intensified surface runoff.

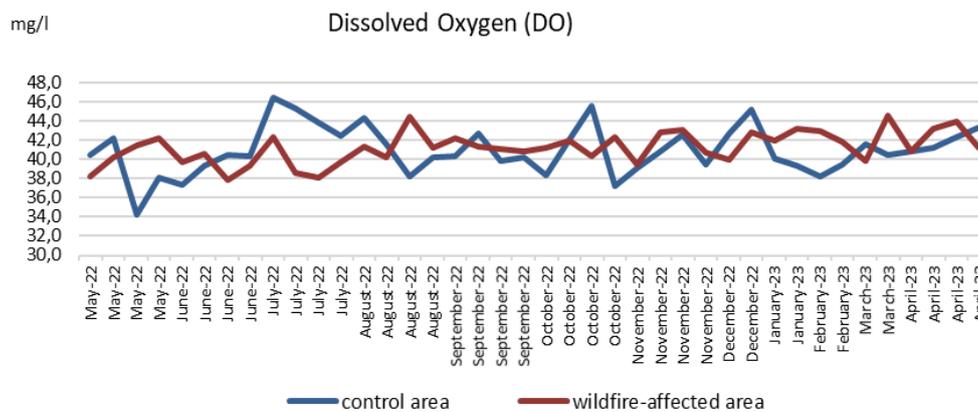
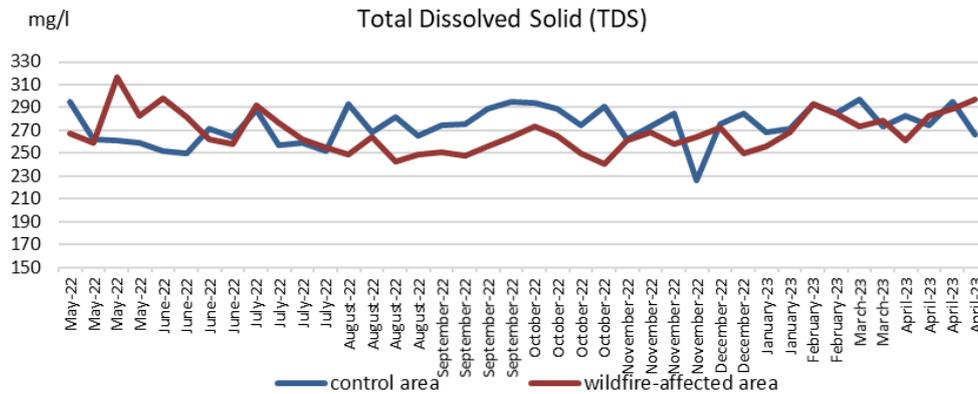


Figure 3. TDS and DO measurements in the wildfire-affected and control areas

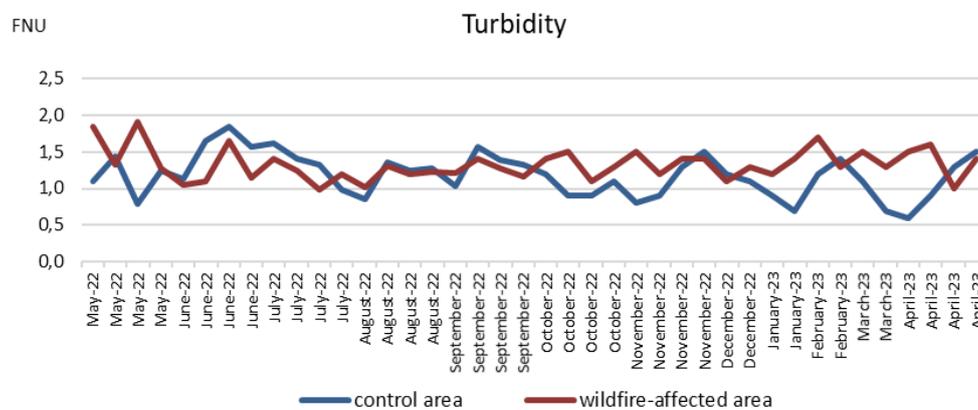


Figure 4. Turbidity measurements in the wildfire-affected and control areas

Table 2. Independent samples t-test results for pH, EC, DO, and turbidity

Parameter	Wildfire-Affected Area (Mean ± SD)	Control Area (Mean ± SD)	t	df	p-value
pH	7.19 ± 0.16	7.06 ± 0.18	3.230	78	0.002 *
EC (µS/cm)	535.65 ± 34.51	550.28 ± 28.13	-2.078	78	0.041 *
DO (mg/L)	41.22 ± 1.68	40.93 ± 2.54	0.589	78	0.856
Turbidity	1.33 ± 0.22	1.18 ± 0.29	2.491	78	0.015 *

*p < 0.05

Table 3. Mann–Whitney U test results for TDS

Parameter	Group	Mean rank	Sum of rank	U	z	p-value
TDS	Wildfire-affected area	34.91	1369.50	576.500	-2.152	0.031*
	Control area	46.09	1843.50			

* p<0.05

Moderate, positive, and statistically significant correlations were identified between pH and electrical conductivity (EC) ($\rho = 0.434$, $p < 0.01$) and pH and total dissolved matter (TDS) ($\rho = 0.446$, $p < 0.01$) in the area affected by the forest fire. These findings suggest that the solubility of ash and inorganic ions in the post-fire environment may have a combined effect on pH, EC, and TDS levels. These results indicate that an increase in the ionic composition of water following a conflagration may also lead to an increase in pH levels. Additionally, the correlation between EC and TDS is nearly one-to-one and of a very high order ($\rho = 0.999$, $p < 0.01$). This outcome validates the premise that electrical conductivity is directly contingent on the quantity of dissolved matter present. Furthermore, post-fire mineral inputs significantly influence both parameters, underscoring the complexity of geochemical processes in fire-affected environments. The absence of a substantial correlation between DO and the other variables indicates that DO may exhibit reduced sensitivity to the physical and chemical alterations after the fire. Alternatively, it is also possible that DO values fluctuated independently of other parameters during the measurement process. Similarly, the turbidity variable does not statistically significantly correlate with the different parameters. This finding indicates that the source of turbidity (e.g., surface runoff and sediment transport) functions independently of other chemical parameters and that the impact of fire on water quality is predominantly evident at the level of dissolved matter (Figure 5).

In the control area, all correlations between pH and other water quality parameters were statistically insignificant and

generally weak, indicating a stable environmental condition with minimal interactive effects among variables. The analysis revealed a strong positive correlation between electrical conductivity (EC) and total dissolved solids (TDS) ($\rho = 0.989$, $p < 0.01$), highlighting the influence of dissolved ions on water conductivity—a phenomenon frequently observed in both post-fire conditions and undisturbed environments. Dissolved oxygen (DO) and turbidity showed no significant associations with other parameters. Although turbidity displayed some negative correlations, these were not statistically significant, further supporting the notion that the control site maintained more stable and precise sediment conditions (Figure 5).

4. Discussion

This study examined the effects of the 2020 wildfire in the Taşköprü district of Kastamonu, Türkiye, on stream water quality.

The results indicate statistically significant differences in pH, electrical conductivity (EC), total dissolved solids (TDS), and turbidity between the wildfire-affected and control streams. Specifically, moderate positive correlations were found between pH and EC ($r = 0.434$, $p < 0.05$) and between pH and TDS ($r = 0.446$, $p < 0.05$) in the wildfire-affected stream. A very strong correlation was observed between EC and TDS ($r = 0.999$, $p < 0.05$), consistent across both sites (control $r = 0.989$, $p < 0.05$). No significant relationships were detected among the remaining parameters.

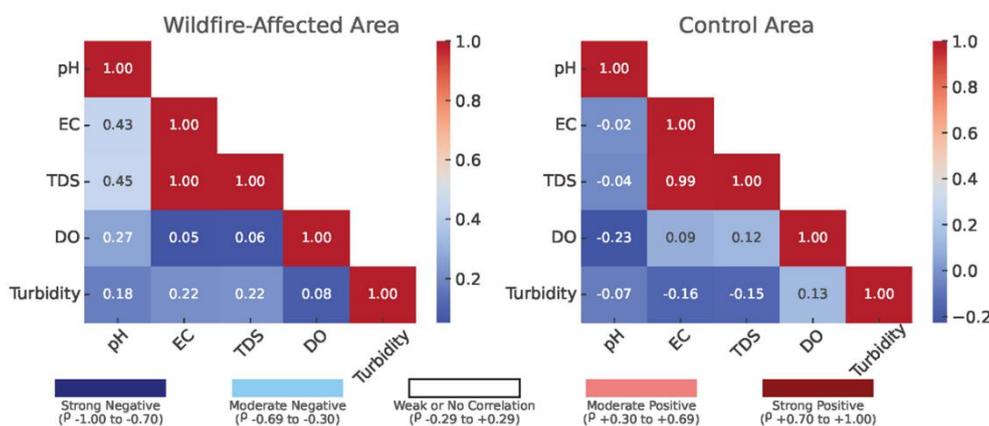


Figure 5. Spearman's Correlation Heatmap for the wildfire-affected and control area

Following wildfires, rain events can transport ash, soil particles, and heavy metals into nearby water bodies, altering their physical and chemical properties (Doerr et al., 2000; Larsen et al., 2009; Nam et al., 2022). Fire-exposed soils often develop hydrophobic layers that accelerate surface runoff, enhance erosion, and facilitate pollutant transport (Moody et al., 2013; Baba et al., 2018; Jumps et al., 2022). Additionally, fires alter soil structure and chemical composition by modifying organic matter, clay minerals, and metallic elements, often increasing hydrophobicity depending on the vegetation type and burn severity (Samburova et al., 2023; Chanasyk et al., 2003; Shakesby and Doerr, 2006; Murphy et al., 2018). These processes elevate the concentration of water-soluble organic matter and enhance the leaching of heavy metals into groundwater (Sazawa et al., 2020; Fajković et al., 2022). Wildfires can significantly alter surface water quality by modifying soil structure, vegetation cover, and hydrological processes. Post-fire deposition of ash, burned organic matter, and hydrophobic surface layers leads to increased runoff, which facilitates the transport of sediments, nutrients, and metal ions into aquatic systems (Moody et al., 2008; Shakesby & Doerr, 2006). This directly impacts key water quality parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, and dissolved oxygen (DO).

Inorganic components in wildfire ash increase water alkalinity, whereas organic acids lower pH due to the dissociation of carboxylic groups (Ferrer et al., 2021; Ferrer and Thurman, 2023). In this study, pH values in the wildfire-affected area were consistently higher than those in the control area, showing statistically significant differences ($p < 0.05$). The positive correlations between pH and both EC and TDS suggest that solute concentrations also rose as alkalinity increased. Several studies report increased pH values following fires (Korsman and Segerstroem, 1998; Rhoades et al., 2011; Costa et al., 2014; Son et al., 2015; Murphy et al., 2018; Güneş Şen and Aydın, 2024). Conversely, other studies reported no change (Burton et al., 2016) or even reductions in pH (Bayley et al., 1992; Allen et al., 2003; Angeler et al., 2004, 2005, 2006; Bladon et al., 2014; Lydersen et al., 2014; Evans et al., 2017; Rodríguez-Jiménez et al., 2024).

Although electrical conductivity (EC) differed significantly between the wildfire-affected and control areas ($p < 0.05$), mean EC values were consistently higher in the control site. This finding contrasts with several studies that have reported increased EC following wildfires (Stankov Jovanovic et al., 2011; Dahm et al., 2015; Sherson et al., 2015), although other studies have observed decreased values (Lathrop, 1994; Allen et al., 2003). Such variability in EC trends may be due to site-specific factors, including fire severity, soil characteristics, and hydrological dynamics. As EC is commonly used as a proxy for total dissolved solids (TDS), its strong correlation with TDS in both study areas further confirms the interdependence of these parameters and highlights EC as a reliable indicator of ionic concentration in freshwater systems. Changes in EC and pH following wildfires have been interpreted in previous research as indicators of long-term water quality degradation, often resulting from the mobilization of ash and associated metal compounds into surrounding soils and water bodies (Kim and Han, 2024). Ash typically contains constituents such as

potassium carbonate, sodium (Na), and magnesium (Mg), which can elevate water pH upon dissolution (Ulery et al., 1993; Pereira et al., 2014; Romero-Matos et al., 2023).

In the wildfire-affected area, TDS levels were significantly lower than those in the control site ($p < 0.05$). While some studies have documented elevated TDS levels in wildfire-impacted environments (Hoffman and Ferreira, 1976), others have reported comparable or even lower concentrations relative to unburned areas (Lathrop, 1994), consistent with the findings of the present study. Research has shown that post-fire increases in TDS may occur due to the breakdown of ash and enhanced erosion processes (Pinedo-Gonzalez et al., 2017; Raelison et al., 2023). Elevated EC and TDS values in surface waters may also signal a long-term risk of salinization following wildfire events.

Although DO levels were slightly higher in the wildfire-affected area, the absence of a statistically significant difference ($p > 0.05$) suggests that oxygen depletion typically associated with the influx of organic matter may have been offset by the stream's re-aeration capacity and flow dynamics. Since organic matter drives respiration in aquatic systems, the post-fire input of substantial quantities of organic material (including ash) into water bodies can lead to reduced DO concentrations (Allan and Castillo, 2007). These findings underscore the importance of hydrological conditions when assessing the impact of wildfires on water quality. While some studies have reported post-fire declines in DO due to ash and organic debris entering water bodies (Dahm et al., 2015; Reale, 2015; Cunillera-Montcusi et al., 2019), other research, consistent with the present findings, has observed increases in DO following wildfires (Paul et al., 2022).

Turbidity was significantly higher in the wildfire-affected stream ($p < 0.05$), likely due to increased erosion and sediment transport following vegetation loss. Higher turbidity reduces light penetration, inhibits photosynthesis, and may impair aquatic habitat quality. Suspended solids also carry nutrients and pollutants, affecting overall water quality (Horowitz and Elrick, 1987; Horowitz, 1991; Ongley et al., 1992; Smith et al., 2011). Other post-fire studies report similar increases in turbidity (Leak et al., 2003; Alexander et al., 2004; White et al., 2006; Sheridan et al., 2007b; Lyon and O'Connor, 2008; Parliament of Victoria, 2008; Nyman et al., 2011; Aközülü and Şen, 2023).

Overall, the findings confirm that wildfires significantly alter stream water chemistry, particularly regarding pH, EC, TDS, and turbidity, and highlight the need for integrated watershed and post-fire management strategies. Although the impacts of wildfires on water quality are short-term, understanding these changes is critical because wildfires cause natural disruptions in many ecosystems, becoming more frequent and severe due to climate change and posing new risks to water resources. They change vegetation and expose soils, reducing infiltration, increasing runoff, and causing greater erosion.

As Hampton et al. (2022) noted, most studies on water quality after wildfires focus on one or two key variables, while a few studies analyze the combination of multiple elemental cycles. This study is one of the few studies that provide short-term water quality monitoring after a large-scale wildfire in Türkiye and analyze multiple interrelated physicochemical parameters. Additionally, the study added

to this body of knowledge by highlighting how wildfires affect hydrological processes and how multiple water quality parameters are affected simultaneously. The sharing of more data for current and future research is considered to significantly support future investigations into the effects of wildfire on water quality, mainly as studies on this topic are increasingly being conducted worldwide. It is widely acknowledged that the increased availability and sharing of data for both current and prospective research can substantially contribute to advancing future studies on the impacts of fire on water quality, particularly given the growing number of investigations being carried out globally on this subject.

5. Conclusion

This study investigated the effects of a large-scale surface and crown wildfire that occurred in 2020 in the Taşköprü district of Kastamonu, Türkiye, on stream water quality. Comparative analyses between the wildfire-affected and control sites revealed statistically significant differences particularly in pH, electrical conductivity (EC), total dissolved solids (TDS), and turbidity parameters. Correlation analyses of these variables demonstrated that water-soluble ions and ash compounds had a marked influence on water chemistry in the post-fire environment.

The formation of hydrophobic soil layers following the fire intensified surface runoff, thereby enhancing erosion and sediment transport, which in turn led to a significant increase in turbidity levels. Moreover, the observed rise in pH values was associated with the dissolution of inorganic compounds derived from ash. The strong correlation between EC and TDS supports the conclusion that ionic concentration increased substantially in fire-affected areas. In contrast, the dissolved oxygen (DO) parameter did not show any statistically significant relationships with other variables, suggesting that DO may vary independently due to hydrodynamic factors.

The findings indicate that wildfires can substantially alter the physicochemical properties of stream water, especially with respect to ionic composition and sediment load. These results underscore the necessity of developing integrated watershed management and water resource protection strategies in post-fire contexts. Furthermore, the simultaneous assessment of multiple water quality parameters in this study provides a valuable contribution to the existing literature.

As the frequency and severity of wildfires continue to increase due to climate change, a deeper understanding of their impacts on water resources is of critical importance—both for advancing scientific knowledge and for informing sustainable environmental planning. In this context, conducting similar multivariate studies across diverse ecosystems will enable a broader understanding of post-fire water quality dynamics at larger spatial and temporal scales.

Acknowledgement

This study was supported by TÜBİTAK "2209-A Research Project Support Programme for Undergraduate Students" with the project number of 1919B012106780.

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