



THE IMPACT OF MINING ON WATER RESOURCES: A COMPILATION OF TURKISH AND EUROPEAN EXAMPLES

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Abstract:

This study is a comprehensive review examining the impacts of quarrying and mining activities on water resources between 1980 and 2026, within the framework of Turkish and European literature. The main objective of the study is to reveal the physical, chemical, and hydrological effects of mining activities on surface and groundwater systems and to evaluate these effects, particularly in the Black Sea Region. Literature findings indicate that mining activities lead to significant deterioration in water quality, particularly through processes such as heavy metal (arsenic, lead, cadmium) accumulation, acid mine drainage, and increased sediment load, negatively impacting aquatic ecosystems. Furthermore, open-pit and quarrying operations have been found to cause a decrease in groundwater levels, disruption of aquifer structure, and alteration of natural drainage systems. European literature emphasizes that these effects persist even in the long term, and abandoned mine sites can create permanent water pollution; however, significant shortcomings are observed in monitoring and managing these processes in Turkey. The Black Sea Region, with its high rainfall regime, steep topography, and dense river network, is extremely sensitive to the impacts of mining activities. The rapid surface runoff and short basin systems in the region cause pollutants to be transported quickly over large areas, increasing the spatial spread of negative impacts on water quality. Furthermore, the region's high biodiversity and ecosystem integrity make the ecological consequences of mining-related degradation even more critical. A comparative analysis of Turkey and Europe reveals that environmental monitoring mechanisms are more effective in Europe, rehabilitation processes are mandatory, and water quality monitoring systems are more advanced. In contrast, despite the existence of legislation in Turkey, shortcomings in implementation and monitoring processes are noticeable. This situation appears to be causing irreversible losses in ecological balance and groundwater. In conclusion, the impacts of mining activities on water resources are multifaceted and often irreversible. These impacts are

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particularly pronounced in hydrologically sensitive areas such as the Black Sea Region. In this context, developing sustainable mining practices, adopting basin-based planning, establishing continuous water quality monitoring systems, and effectively implementing rehabilitation processes are of great importance.

Keywords: mining, water resources, Black Sea region, quarry

1. Introduction

1.1. Mining

Mining activities are one of the most intensive sectors in the use of natural resources and have the most pronounced environmental impacts. Neoliberal economic policies adopted globally after 1980 led to the emphasis on the economic value of natural resources; in this process, mining activities accelerated, especially in developing countries (Bridge, 2004). Turkey was also affected by this transformation, and the mining sector has shown significant growth since the 2000s (Turkish Ministry of Energy and Natural Resources, 2021; World Bank, 2019).

In Turkey, a significant portion of quarries, marble operations, and metallic mining sites are located in geographical areas that overlap with water catchment areas, forest ecosystems, and agricultural lands. This spatial overlap causes pressure on water resources in terms of both quantity and quality. Open-pit mining activities, in particular, increase surface runoff and sedimentation. It accelerates the transport of water and leads to significant changes in its physical properties (Akcil & Koldas, 2006; Turoğlu, 2011).

Various field studies from Türkiye clearly demonstrate the impacts of mining on water resources. For example:

- Studies conducted in the Eastern Black Sea region show that quarries cause increased turbidity in stream beds and degradation of aquatic ecosystems (Turoğlu, 2011; Yıldız & Karabulut, 2018; Aksoy & Soylu, 2023).
- In coal mining areas in the Western Black Sea region, increased concentrations of iron and sulfate have been detected in groundwater (Younger, 2001; Karaca & Nichol, 2004).
- Water quality problems associated with arsenic and heavy metal pollution around gold mining activities have been reported in the Aegean Region (Akcil & Koldas, 2006).

Furthermore, it has been observed that in areas where mining activities are concentrated in Turkey, water resources are negatively affected not only in terms of quality but also in terms of quantity. In particular, crushing and screening processes and mine drainage practices carried out within the scope of open-pit mining lead to significant decreases in groundwater levels; this disrupts the recharge balance of aquifer systems and puts pressure on the water budget (Younger, 2001; Akcil & Koldas, 2006).

Although the Environmental Impact Assessment (EIA) processes currently in effect in Türkiye theoretically include mechanisms for protecting water resources, there

are various shortcomings in practice. Many studies indicate that EIA reports do not contain sufficient hydrological analysis and that long-term monitoring processes are inadequate (Çevik, 2022).

The situation is even more critical in the Black Sea Region. The region's high rainfall regime, steep topography, and dense river network accelerate the impact of mining activities on water systems and cause them to spread over wide areas. Therefore, the Black Sea is considered one of the most sensitive regions in Turkey in terms of the mining-water relationship (Turoğlu, 2011; Doğanay & Coşkun, 2012).

1.2. The Impact of Mining on Water Resources in Europe

Studies conducted in Turkey and Europe reveal that quarries have multifaceted impacts on water resources. These impacts are generally classified as hydrological system changes, chemical water quality degradation, and physical environmental pressure.

In general, the literature indicates that mining activities in Turkey have three main impacts on water resources: deterioration in water quality, decrease in groundwater levels, and structural changes in aquatic ecosystems (Turoğlu, 2011; Akcil & Koldas, 2006). These impacts manifest with varying severity depending on regional geomorphological and climatic characteristics.

European literature presents similar findings. In Italy, the effects of quarries on hydrogeological systems have been studied, and changes in groundwater flow patterns have been identified (Paoletti *et al.*, 2025). In Germany, Belgium, and Poland, quarries have been found to cause a decrease in groundwater levels, an increase in salinity, and chemical degradation (Friese & Döll, 2005; Rózkowski & Twardowska, 2004).

The long-term effects of abandoned quarries in England and Spain are particularly noteworthy. In these areas, acid mine drainage (AMD) has been reported to cause a significant drop in water pH and the accumulation of heavy metals over many years (Younger, 2001; Sainz & Grande, 2000).

Region / Country	Work Area	Type of Effect	Findings / Data
Italy	Limestone quarries	Hydrogeological system influence	It has been determined that quarries alter groundwater flow patterns.
Germany	Quarries and mining areas	Groundwater level drop	A long-term decline in the water table and the need for continuous pumping have emerged.
Poland	Limestone quarries	Water salinity and chemical changes	A 5–10-fold increase in the electrical conductivity of groundwater has been observed.
England	Abandoned quarries	Heavy metal and AMD	Long-term water pollution continues due to acid mine drainage.
Spain	Mines and quarries	Acidic drainage	The pH level of the river water has dropped to 2–3.
Belgium	Karstic quarries	Groundwater system replacement	Periodic fluctuations have been observed in groundwater levels.

1.3 The Impact of Mining on Water Resources in Türkiye

Field studies conducted throughout Turkey reveal that mining activities have regionally varying but generally negative impacts on water resources. Studies in the Black Sea Region, particularly in provinces such as Zonguldak, Bartın, Rize, Trabzon, and Artvin, show that quarrying and coal mining activities cause increased turbidity in surface waters, higher sediment loads, and degradation of aquatic ecosystems (Turoğlu, 2011; Karaca & Nichol, 2004). These effects spread more rapidly due to the region's high rainfall regime and steep topography.

In provinces such as Eskişehir and Afyonkarahisar, located in the Central Anatolia and Aegean Regions, it has been determined that groundwater recharge areas have narrowed and water table levels have decreased due to marble and stone quarries (Doğanay & Coşkun, 2012). This situation creates significant pressure, especially in terms of water quantity.

In the Eastern Anatolia Region, mining activities in provinces such as Elazığ, Sivas, and Erzincan have resulted in increased levels of sulfate, iron, and other heavy metal ions in groundwater (Yıldırım & Ersoy, 2015). These chemical changes directly affect the drinking and agricultural water quality. Toxic substances such as cyanide and arsenic pose a risk to water resources in areas where gold mining activities are intensive, such as Balıkesir and Uşak (Akcil & Koldas, 2006). These findings show that mining activities create not only physical but also serious chemical pollution.

Studies conducted in limestone and aggregate quarries in Istanbul show that blasting activities affect the groundwater flow regime and disrupt the hydrogeological balance (Kuzu & Ergin, 2005). Similarly, it has been reported that quarries in the Cebeci region create high environmental pressure in terms of water and energy consumption and pose risks to sustainability (Vural *et al.*, 2025).

Research conducted in the Burdur Basin has revealed that marble quarries cause deterioration in both surface and groundwater quality and lead to a decrease in water quantity (Özçelik, 2023). In limestone quarries in and around İzmir, it has been determined that the natural recharge processes of aquifer systems have changed and the groundwater balance has been disrupted (Barthélemy *et al.*, 2016).

Region / Province	Mineral Type	Effect on Water	Observed Result / Data
Zonguldak	Coal	Deterioration of groundwater chemistry	Increased iron and sulfate levels lead to a decrease in the water table.
Bartın	Coal	River pollution	Acidification trend in stream waters.
Kastamonu	Stone quarries	Sediment increase	Increased turbidity in rivers.
Rize	Stone quarries	Aquatic ecosystem degradation	ASKI increase 2-5 times
Trabzon	Roads/quarries	Surface water flow change	Post-precipitation sediment increased transport
Artvin	Copper/gold	Heavy metal pollution	Increase in As, Cu, Pb

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Giresun	Stone quarries	River turbidity	Decrease in the quality of drinking water sources.
Army	Stone and small-scale mines	Decrease in groundwater recharge.	Aquifer recharge area shrinkage
Balıkesir	Gold mine	Chemical risk	Risk of cyanide and arsenic.
Servant	Gold mine	Water quality deterioration	Increase in heavy metals (As, Hg)
Eskisehir	Marble quarries	Water level decrease	Decrease in groundwater level
Afyonkarahisar	Marble	Surface water exchange	Disruption in the river regime
Elazığ	Copper mine	Chemical pollution	Increase in sulfate and metal ions
Sivas	Zinc/lead	Groundwater pollution	Heavy metal accumulation
Erzincan	Gold mine	Water ecosystem pressure	in river sediment load
Istanbul (Türkiye)	Limestone quarries	Groundwater flow and vibration effect	It has been determined that blasting activities affect the groundwater flow regime and environmental balance.
Cebeci – Istanbul (Türkiye)	Aggregate quarries	Water consumption and environmental burden	Quarries have been reported to create high environmental pressure in terms of water and energy consumption.
Burdur (Türkiye)	Marble quarries	Water quality and quantity loss	Pollution in groundwater and surface water, and a decrease in water levels have been observed.

3. Conclusion and Recommendations

3.1 Conclusion

This review study provides a multi-dimensional assessment of the impacts of quarrying and mining activities on water resources in Turkey and Europe between 1980 and 2026. Literature findings indicate that mining activities have significant and often lasting hydrological, chemical, and ecological impacts on water systems.

In the case of Türkiye, mining activities are particularly prevalent in the Black Sea, Aegean, Central Anatolia, and Eastern Anatolia regions:

- A decrease in groundwater levels,
- Deterioration in surface and groundwater quality (accumulation of heavy metals, sulfates, arsenic),
- sediment and turbidity in river systems,
- structural damage in aquatic ecosystems (Akçil & Koldas, 2006; Turoğlu, 2011; Yıldırım & Ersoy, 2015).

European literature shows that these effects persist not only during the operation but also for many years after mining activities have ended. Processes such as acid mine drainage (AMD) and increased salinity in groundwater systems, in particular,

demonstrate that the reversal of environmental impacts is difficult (Younger, 2001; Sainz & Grande, 2000).

In the Black Sea region specifically, the high rainfall regime, steep topography, and dense river network cause pollutants to be transported rapidly, leading to the spread of mining-related impacts over wider areas. This makes the region one of the most sensitive areas in Türkiye in terms of water resources.

Overall, the study demonstrates that the mining-water relationship is not only an economic activity but also a critical ecological risk area in terms of sustainable environmental management.

3.2. Recommendations

Based on the study findings, the following recommendations have been developed:

3.2.1 The Obligation of Basin-Based Planning

Mining activities should be planned based on water catchment areas; in particular, the opening of new mines should be restricted in drinking water catchment areas.

3.2.2 Special Protection Status for the Black Sea Region

Due to high rainfall and sensitive topography, stricter environmental restrictions should be applied to quarries and open-pit mining operations in the Black Sea Region. In this context, mining activities, particularly in Trabzon and Giresun provinces, as recently reported in the press, should be reviewed again; ecological, natural, and human factors should be considered, and importance should be given to the protection of water resources, which is a problem for the future.

3.2.3 Widespread Adoption of Water Quality Monitoring Systems

Heavy metals, pH, and conductivity in groundwater and surface water should be monitored regularly, and publicly accessible data systems should be established.

3.2.4 Strengthening EIA Processes

Environmental Impact Assessment reports should include long-term hydrological analysis, covering not only the project phase but also the post-operation period.

3.2.5 Obligation for Rehabilitation and Restoration

Ecological restoration of post-mining sites should be made a legal requirement, and monitoring mechanisms should be strengthened.

3.2.6 Compliance with European Standards

Environmental rehabilitation processes following mining operations in Turkey should be harmonized with European Union environmental legislation.

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Conflict of Interest Statement

All research in this article was recorded by me and there was no contribution from third parties.

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