JOURNAL OF DEGRADED AND MINING LANDS MANAGEMENT
Volume 10, Number 3 (April 2023):4517-4525, doi:10.15243/jdmlm.2023.103.4517
ISSN: 2339-076X (p); 2502-2458 (e), www.jdmlm.ub.ac.id

Research Article

Environmental effects of marble quarry operations in Burdur Lake Basin (Burdur-Turkey)

Mehmet Ozcelik*

Geological Engineering Department, Suleyman Demirel University, Engineering Faculty, Isparta, Turkey

*corresponding email: ozcelikmehmet@sdu.edu.tr

Article history:
Received 23 November 2022
Accepted 17 January 2023
Published 1 April 2023

Keywords:
lake
marble quarries
pollution
uncertainties
water

Abstract

Marble is the most important natural material because of its structural features and its long durability. It is mined at operated quarries on hill slopes. The original landform is permanently altered, and vegetation cover is destroyed. Another important feature of marble quarries is the large amount of waste materials released during the quarrying process. In the last decades, together with the visible effects of global warming and climate change, fresh water resources are rapidly depleted and polluted due to careless land use. Quarrying operations are among the most important stakeholders of this process. Environmental effects of quarry activities depend on the location of the site in the landscape, the vertical and horizontal dimensions of the excavation, the methods used to excavate the marble, and the formation of the geological structure. Furthermore, the region's seismicity, microclimate conditions, ecological condition, and surface and groundwater conditions are all factors influencing environmental degradation. Additionally, numerous serious environmental impacts associated with quarrying activities near the site, such as visual pollution, water, dust, noise, air pollution, vibration, land subsidence, and landslides, will cause health issues and unpredictable biodiversity loss. Quarrying operations have the potential to impact pre-existing ecosystems, including groundwater depletion, loss of fertile topsoil, forest degradation, and human health. This article aims to draw attention to various serious environmental impacts, health problems and biodiversity loss resulting from quarrying operations in Burdur Lake Basin.

To cite this article: Ozcelik, M. 2023. Environmental effects of marble quarry operations in Burdur Lake Basin (Burdur-Turkey). Journal of Degraded and Mining Lands Management 10(3):4517-4525, doi:10.15243/jdmlm.2023.103.4517.

Introduction

Turkey is located in the Alpine belt, where the world's richest natural stone formations are located. It has a wide variety and a large amount of marble reserves. In addition to these resources, Turkey is among the most important natural stone producers in the world with its developing industry and the technology it uses in production. Afyon, Bilecik, Balikesir, Denizli, Muğla, Burdur, Amasya, Elazığ and Diyarbakır are the provinces where the reserves are concentrated. In our country, marble reserves of more than 80 different structures and more than 120 different colors and patterns have been identified. There are more than 500 quarries, more than 900 factories and around 5000 workshops in the sector. The natural stone industry in Turkey has made significant progress in the last ten years (Ozcelik, 2016). Turkey has taken its place among the world's most important natural stone producers with its rich reserves and developing marble processing industry. Especially in the recent period, thanks to the investments made by large companies, modern quarry production methods and the latest techniques, a great increase has been recorded in the

production of processed marble. Turkey has an important place in the world's natural stone industry. It is estimated that 33% of all marble reserves in the world and 40%, according to some sources, are in Turkey. With a total reserve of 13.9 billion tons (approximately 5.1 billion m³), Turkey's apparent reserve of 13.9 billion tons is in a position to meet the need of world consumption for approximately 80 years (Şengün and Bilgin, 2022). Turkey, which has approximately 40% of the world's natural stone reserves, ranks ninth in the world natural stone sector with a share of 3.1% in production and eighth in exports with a share of 2.3%. One of the most important reasons for this imbalance between the figures is the fact that processed products with high added value are not given importance in our natural stone and marble exports, and they are exported as blocks (Yılmaz and Caran, 2019). This situation is also seen in the marble enterprises carried out in the Burdur Lake Basin. Block marble production is exported as raw material (TCTB, 2021).

This article discusses the risks associated with quarrying operations in Burdur Lake Basin. The findings will be used to develop best management and pollution control practices for future quarry operations at other locations.

Materials and Methods

Study site

The region has rich mineral diversity and important mineral deposits due to its geological structure. Burdur, is one of the most important marble centers in Turkey (TCBV, 2021; Figure 1). Sampling plays an especially important role in environmental studies and decisions. In most environmental studies, field samples are collected from various field locations. The characteristics measured in those samples and any consequent subsamples, including laboratory subsamples, are then considered, de facto, as being “representative” of the site from which they were collected. The selected region in this study has rich mineral diversity and important mineral deposits due to its geological structure. Burdur, one of the most important marble centers of Turkey, is known for its marble branded as "Burdur Beige". There is marble in the mountains of almost all districts of Burdur and it is very rich in terms of reserves. Approximately 45-50 marble quarries were opened in the Mesozoic limestones located in the southwest of Burdur Lake (404.8 ha = 4048 decares = 4 048 000 m^2). 28-30 of these marble quarries are located in the north of the line between Lake Yarisli and Lake Burdur.

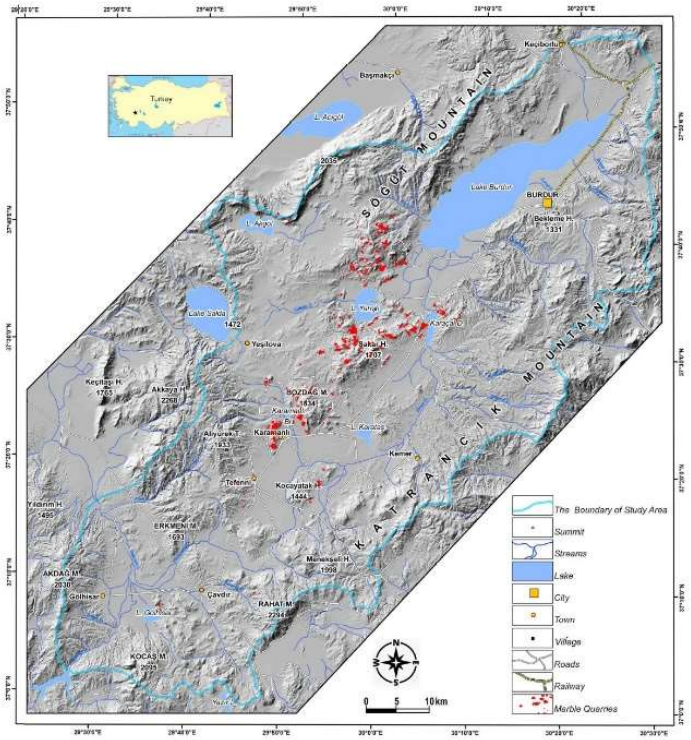


Figure 1. The distribution of marble quarries in Burdur-Gölhisar Basin (TCOB, 2019).

Marble quarries around Burdur Lake were examined in sample collection. The production data of companies engaged in commercial marble extraction for export were accepted as the classification criteria of the samples. The technical data of the samples are trademarks by the companies producing in the field. In the region, there are beige, brown, cream, black and bluish marble varieties that have been recorded in the

world literature as Burdur beige. Burdur beige is a type of marble that is sought after and demanded due to its hardness and durability.

Characteristics of the region

Burdur Lake is Turkey's 7th largest lake. Burdur Lake has the protection status of Ramsar Area, Natural Protected Area and Wildlife Development Area (Figure 2). Although the life of all living things, including the people living around Burdur Lake, depends on the existence of the lake, Burdur Lake is drying up. The lake's water level had dropped 19.94 meters since May 1970, when it reached its highest level. With the effect of drought, the lake is in danger of drying out, and the retreat continues rapidly. The elevation of Burdur Lake, which was measured as 857.62 meters in May 1970, decreased to 837.68 meters in October 2022 in the intervening 52 years, and decreased to 19.94 meters. In 52 years, the surface area of the lake decreased by 50 percent, from 237 square kilometers to 117 square kilometers. Marble mining, as in other mining activities, it can be handled in three phases as exploration, operation and mine closure. Minimizing the environmental impact in both exploration activities and open-pit marble mining is an integral part of mining activities. Construction machinery and wastes used during exploration activities and drilling operations, roads opened for access to the site, trial productions and the lack of rehabilitation after leaving the field create serious problems in terms of health, safety and environmental impact. In open quarry marble production, it consists of processes such as obtaining large blocks, cutting and polishing with construction machines. Various environmental effects occur due to the methods used during these processes. These negative effects should be minimized. In order for the quarries to be put into operation in marble mining, first of all, suitable areas should be selected, and then the vegetation should be stripped, and the landform should be reshaped. Thus, the natural ecological structure and appearance of the operated area are changing. It is seen that the negative effects of this destruction and the balance of public interest work negatively for the Burdur basin (Tercan and Dereli, 2021).



Figure 2. General view of the marble quarries.



Figure 3. Marble waste in and around the marble quarry and maquis vegetation mostly consisting of kermez oaks on the marbles.

Marble production has both positive and negative societal impacts on surface and groundwater, biodiversity, microclimate conditions, ecological condition, health, and the environment in general. To that end, an assessment of the environmental impacts of marble quarry activities near Burdur Lake was conducted, and some recommendations were made.

Surface and groundwater

Quarrying has a common impact on surface and groundwater quality because of increased fine sediment concentrations and unintentional spillages. Burdur lake is one of the deepest lakes in Turkey, located in the Lakes Region. It is an E-SW trending tectonic lake. The feeding of the lake, which is a closed basin, precipitation is by surface runoff and groundwater flow from aquifers. The discharge takes place only by evaporation from the lake area. The waters of Burdur Lake have a very high concentration of dissolved ions due to the high evaporation rate. The waters of Burdur Lake are classified as undrinkable quality waters and are Na-Mg-(Cl)-SO_4-HCO_3 type waters (TCOB, 2019). The number of marble industry companies that have obtained more than one groundwater drilling exploration permit is 27 company. The number of marble companies that obtained a license to use underground water drilling is 31 companies, the number of companies that did not receive it is 27, and the number of companies that have been granted a one-year extension is 1.5 of these companies are for irrigation purposes and 71 for use. The total amount of groundwater allocated annually is 1,082,061 cubic meters (TMMOB, 2014) .

Damage to biodiversity

Damage to biodiversity is one of the most serious environmental consequences of marble quarrying. Biodiversity refers to the variety of living organisms, such as fish, insects, invertebrates, reptiles, birds, mammals, plants, fungi, and even microbes. Biodiversity protection is critical since all species are

interconnected, even if this is not immediately apparent or even recognized, and human survival is dependent on the delicate balance that occurs in nature. Marble production has a significant negative impact on biodiversity.

Flora

Burdur Lake, Turkey's seventh largest lake and second largest brackish lake, is one of 305 "Important Natural Areas" in Turkey. In the study of the flora around Burdur Lake, 70 families, 275 genera belonging to these families and 465 taxa belonging to these genera were determined as a result of the evaluation of approximately 1005 plant samples collected from the research area (MAKÜ, 2012). According to MAKÜ report (2012), the richest family in terms of taxa number is Compositae (Asteraceae), and the richest genus in terms of taxa number is Centaurea L. The number of detected endemic taxa is 49, and its ratio to the total number of taxa is 10.53%. The distribution of taxa according to phytogeographic regions is as follows: Iran-Turanian Element 55 taxa (12.04%), Euro-Siberian Element 23 (4.95%) taxa, Mediterranean Element 98 taxa (21.07%), 289 taxa (61%) are widely distributed (multi-regional), and the phytogeographic region is not defined. It has been determined that 20 of the detected species are endemic in the region.

Fauna

Due to its wildlife nature, Burdur Lake has been declared a "Waterbirds Wildlife Protection Area" and included in the RAMSAR list. Although the productivity of the lake is very low, it is very important ecologically because it provides an important accommodation and living environment for waterfowl. This importance; Fulica atra (Sakar Meke), which constitutes the most important bird population of the lake and whose numbers have decreased by 50% in 2004, and which are very unevenly distributed in an area extending from the Western Mediterranean to the Central Asian Steppes, and their populations are small worldwide. It gained international value in terms of protection of the lake since more than 70% of the populations of the Dikkuyruk ducks (*Oxyura leucacephala*), which are included in the "Rare" Category by the International Union for Conservation of Nature and Natural Resources, prefer the lake as a wintering area (MAKÜ, 2012).

There are 210 different bird species, 19 reptile and amphibian species and 7 mammal species living in and around Burdur Lake. There are 12 different butterfly species known to exist in the region, of which *Pseudochazar lydia* (Lydian false witch) is an endemic species. Burdur-toothed carp (*Aphanius sureyanus*) lives only in Burdur Lake in the world. Burdur Lake is the most important wintering area for Dikkuyruk in the world and hosts at least 60% of the whole world's population in winter. In February 1991, 10,927 Dikkuyruks were counted in the lake. 121 bird species were recorded in Burdur Lake in the period of April 1997. 1451 Dikkuyruk census was made in January 1999 in the lake. Around 800 Dikkuyruk ducks were counted in 2007-2008, 1223 in 2009, and 920 in 2010 (TMMOB, 2014). While quarries can have significant environmental impacts with proper planning and management, most of the negative impacts can be minimized or controlled. In many cases, there are great opportunities to protect and improve the environment, such as by relocating existing habitats or creating new ones.

Dust pollution

Another waste that pollutes the environment is marble dust. During production, a large portion of it is disposed of at a dumpsite near the manufacturing units (Karbous et al., 2020). The disposal of this waste has an impact not only on the ecology but also on the quality of groundwater (Atiyeh and Aydin, 2020). Marble dust is the dust particles that are released during the cutting of blocks and plates, and the majority of them are below 1 mm. In order to control dust, dust absorbing systems, filtration and plenty of water should be used. While the Burdur Region and its water basin should come to the forefront as an area that must be protected above all, it can be seen with the naked eye that none of these studies and precautions has been carried out in order to minimize the negative effects on natural life, people and the environment, in the examinations carried out in different quarries with operating permits.

Soil pollution

In the Burdur Lake basin, alluvial soils, alluvial coastal marshes, hydromorphic alluvial soils, colluvial soils, saline, alkaline and saline-alkaline (barren) soils, organic soils, brown forest soils, chestnut soils, bare rocks and debris, river-floodplains. There are ten different soil groups in total. Zonal and intrazonal soils, which are formed as a result of the dominant effects of climate-vegetation and parent material-topography combination, cover a very large area in the sub-basin formed by the lands around Burdur Lake.

Noise pollution

The quarrying of marble entails a number of activities that produce a significant amount of noise. It begins with road access, followed by preparatory activities such as the establishment of other processing plants. The next step is to cut the block that will be extracted. The top soil layers are removed with a scraper, hydraulic excavators, and dump trucks. It will have a lot of noise after this stage. Cutting and moving blocks adds even more noise to the environment. Mining, drilling, construction, agriculture, energy, industry, and development projects, as well as the extraction of raw materials from their natural environments, all have a significant impact on the environment.



Figure 4. Machine, machine power and sound power level for each sound source.

When the values of other quarries in the field are added to the sound power level determined for the machinery and equipment in only one marble quarry, it is clear that noise pollution has a significant impact on many migratory birds, including egrets, white-headed ducks, and flamingos.

Air pollution

Quarry dust is a significant source of air pollution, though the severity varies depending on factors such as local microclimate conditions, dust particle concentration in ambient air, particle size, and chemistry (for example, limestone quarries produce highly alkaline and reactive dust). Dust can have physical effects on the surrounding plants, such as blocking and harming their internal systems and abrasion of leaves and cuticles, as well as chemical consequences that may impair long-term survival (Gabarron et al., 2019). Dust from marble quarries around Lake Burdur has long been recognized to harm vegetation and lower crop yields, posing a hazard to plant life in industrial regions. Farmers claim that such dust reduces growth, height, and leaf number. Its hazardous chemicals, such as fluoride, sulfuric acid, and hydrochloric acid, are known to be damaging to vegetation in addition to the produced dust.

Waste production

The large irregular block pieces and other rock fragments generated during the operation should be transported to the most suitable place and stored, and then reused as a filling material in the mine closure process. However, the large irregular block pieces and other rock fragments are poured out of the quarries in a way that creates the least cost for the operator. The size of the environmental destruction area created by the enterprise is greatly increased. This situation is clearly seen in all the quarries examined. While the process is running like this, the implementation of mine closure and rehabilitation projects, which were prepared and approved within the framework of project approvals, at the end of the work is only a product of imagination. It is obvious that no action has been taken regarding this rehabilitation, both in the enterprises operating in the immediate vicinity of the settlement areas and in the abandoned quarries in the natural areas that need protection. In marble quarries, large irregular block pieces and other rock fragments that have no economic value are defined as rust and are stored in the area closest to the quarry (Celik and Sabah, 2008). The rock fragments exposed during and after the excavation are poured into the rust casting area regardless of size differences (Figure 5). For the waste from different quarries, a common waste dumping area should be created in the area to be determined outside the basin.



Figure 5. Production and waste materials at the quarry.

Reducing the impacts of marble quarrying

Technological improvements are essential to use modern machinery and equipment to reduce the ultimate sustainability and environmental impact of marble mining. These include wheel loaders, dump trucks, compressors, vertical cutters, drilling machines (hydraulic drills and line drills), and hydraulic excavators. As a result, it will reduce the environmental impact of marble production while also improving product quality. It is extremely difficult, even impossible in some areas, to restore the currently operating marble quarries with the completion of the economic operation. First of all, it should be noted that it is not possible to restore the slope as a result of natural erosion of the steps formed by removing the marble along the slopes in the karstic lands. Because the infiltration of precipitation waters along the cracks prevents erosion and does not allow the steps to be flattened. As in other mines, such as coal and sand, it is not possible to fill and level the excavation sites with construction equipment.

The works required to rehabilitate the marble quarries, that is, to ensure the natural balance as much as possible, are as follows;

a. Materials consisting of marble pieces of various sizes coming out of the marble quarries should be filled on the terraces in the quarries. However, these materials are not sufficient to create a slope close to the natural topography by filling the steps

in the form of terraces. In other words, the stepped structure in the marble quarries will remain substantially the same as there is not enough filling material.

b. On the marble steps of the quarry, the debris should be laid out like earth, and shrubs or trees such as xeric herbaceous plants and kermez oak should be planted on it. In such an application, herbaceous plants will be able to grow.
c. Natural slope profile can be gained by covering the pits and terraces in marble quarries by carrying easily excavated vegetal soils.
d. The only thing to be done is to lay the existing debris on the terraces in the marble quarries as much as possible and to plant these areas with kermez oaks and red pines, which are very resistant to drought.

Results

Marble quarries reveal an ugly topography where the natural balance is disturbed. For this reason, a method of operation should be applied to ensure that the marble quarries are not opened haphazardly, they should be built in areas with high reserves and low elevations, and that the debris from the quarry will restore the topography as close as possible to its former state (Figure 6). In final words, marble quarries have not only caused irreparable damage to the natural environment of the Burdur basin but also caused an ugly appearance and developed negative effects on the sustainable environment. In other words, red pine and maquis vegetation in the area where the marble quarries are located decreased the productivity, biomass yield and carbon dioxide stocking in the air, and accordingly, some of the grazing lands of the goats disappeared (Figure 7). On the other hand, dust from marble quarries filling the leaf stomata reduces the growth of trees and shrubs, fills the pores of the soil, reduces water and air circulation in the soil, and causes the soil to harden, resulting in a decrease in agricultural productivity.



Figure 6. The effect of slope debris formed by marble quarries wastes on settlement areas.



Figure 7. The effect of marble quarries on natural appearance and vegetation.

Considering a very long process, it can be said that the economic contribution to our economy from the operation of the marble quarries will be below the biomass gain obtained from the marble quarries.

Discussion

Marble quarry enterprises have a negative impact on environmental elements such as the general structure of the earth, vegetation, air, underground and surface waters (Ozcelik, 2016). Operating activities in marble quarries include pickling and marble production. As a result of these activities, masonry hills and deep depressions are formed, which disrupt the topographic structure of the land. Due to the negative image that this landscape adds to the surrounding image, it has caused reactions in the psychological dimension. Considering the problem of knowing the damage of marble quarries to the environment, the degree of harmful effects, their protection and elimination criteria, it is seen that they are less harmful than other industries and only disadvantageous in terms of visual impact (Ahmad et al., 2022). Turkey is at the forefront of world mining in terms of marble reserves. A significant part of mining exports is carried out through marble. However, it can be said that it is very difficult to talk about the public interest when we look at the added value and the negative balance it creates. Marble, which is extracted by creating serious health, safety and environmental problems, is sold abroad in blocks without being processed, and the negativities it creates will be inherited by the people for generations (Ako et al., 2015; Noreen et al., 2019; Rashedi et al., 2020). It has been clearly observed today for the Burdur Region that these works, which are carried out without creating the right mining strategies and plans, not in accordance with the science and technique of mining, and without considering the public interest, are not sustainable. It is a vital responsibility for our country's present and future generations to abandon this mistake as soon as possible and to plan and

implement marble mining in appropriate areas, in accordance with mining techniques and with an understanding that puts the public interest first. Mining activity alone is misleading to assess the impact of operating a single quarry (Singh et al., 2017). The cumulative effect of the mines in the lake basin should be evaluated in terms of their effects on agriculture, forest and pasture, and their socio-cultural-economic effects (Akbulut and Gürer, 2003; Bilgin and Koç, 2012). There are marble quarries adjacent to the residential areas in the lake basin, which are almost intertwined. With its location adjacent to the residential areas, the use of the routes connecting the settlements to each other in marble transportation without taking any precautions poses a significant risk in terms of traffic, apart from the dust effect (Maponga and Munyanduri, 2001; Stehouwer et al., 2006). There are mines almost everywhere in the basin, close to the lake, on transportation routes, in forest areas, and in the middle of agricultural areas (Peñaranda Barba et al., 2021). It is seen that even the life safety of the inhabitants is not taken into account in the location selection of the mines. It is not clear under which criteria a marble quarry permit is granted. In addition, it is important to determine how the water to be needed in the mine will be met. The use of wells or spring waters where groundwater is used will also have a negative impact on the Lake water system. In addition, it is certain that the water-containing marble dust that comes out after use will have an effect similar to the effect of powdered marble on the soil. With the removal of marble blocks, the natural structure undergoes a change. In order to minimize these changes and their effects and to minimize them, a quarry operation plan is needed.

Conclusion

Each stage of the quarrying cycle, such as exploration, production, processing, and transportation, has an impact on the environment. These include visual pollution, water pollution, dust, noise pollution, air pollution, vibration, land subsidence and landslides, all of which will cause health problems and unpredictable biodiversity loss. Burdur Lake is one of Turkey's 14 internationally important RAMSAR sites. In this context, suggestions developed for the implementation of mining applications that will provide high-added value to the economy of the region and the country on the basis of public interest are given below. For the continuity of the lake ecosystem, which is formed by the natural features that constitute the reason for the national and international nature protection status of Burdur Lake and its basin, first of all:

1. Calculations regarding the Burdur Lake basin water budget, dams and ponds in the basin, irrigation, drinking water, etc. It reveals that the geological-meteorological processes of the basin, together with the amount of surface and groundwater used for purposeful purposes, can have a negative impact on the water budget of the lake. For this reason, in order to prevent the level decrease in the lake immediately and to ensure the water balance in the lake;
   - Determination of surface and groundwater potential in the basin,
   - Determining the current water consumption in the basin,
   - A comprehensive geological, geophysical, hydrological and hydrogeological research study is required to determine how the sectoral water demands in the basin will be met without damaging the lake. Considering the fact that the continuity of the Burdur lake ecosystem depends on the protection of the basin as a whole, planning should be done at the basin level for the effective management of the area. Transition to Integrated Watershed Management should be ensured.
2. In order to protect the habitat of the two endemic fish species living in Burdur Lake, it is imperative to ensure the sustainability of the Lake ecosystem.
3. The Management plan change that allows mining activities within the wetland buffer zone should be abandoned.
4. Exceptional practices within the Buffer Zone should be abandoned. New construction areas should not be allowed.
5. Coordinated and effective management of wetland nature, RAMSAR Area, Natural Site status, Wildlife Development Area protected area status should be ensured.
6. Mining activities identified as important problems for the Burdur Lake Basin should be included under a separate heading in the Burdur Lake Management Plan and clear decisions should be made.
7. In determining the environmental impacts of marble quarries, the cumulative impact on the environment should be determined by considering the lake basin as a whole, not separately for each marble quarry.
8. For the mining activities carried out in Burdur marble deposits, which have an important place in Turkey's mining;
   - The public interest should be considered as a priority. Wetland protection zones should be closed to all mining activities.
   - Enterprises that do not comply with the science and technique of mining and pose a risk for both settlements and the natural environment should be closed.
   - Precautions should be taken against the risks posed by abandoned quarries that have not been rehabilitated.
   - Practices that pose both environmental risk and threaten the continuity of the Lake ecosystem, such as random waste dumping, should be stopped.
   - A transportation plan should be made to reduce the risk arising on the routes connecting the

settlements due to heavy tonnage vehicle traffic. Transportation infrastructure should be built in accordance with heavy tonnage traffic.
- Regarding the marble mining sector, an approach that considers risks in terms of human life and environmental values such as lake ecosystem, forest existence, natural life, underground water, which is the reason for international nature protection status, should be adopted. In line with this approach, application rules should be determined in accordance with the science and technique of marble mining.
- Participation of the relevant local people should be ensured in the decisions to be taken regarding the mining sector.
- It is not possible for any sector plan or plan implementation to be prepared without the direct participation of the parties in question.

9. A monitoring system should be established throughout the basin. A monitoring system should be established to monitor the lake level and area changes, water quality and meteorological data, the accumulation of marble dust, habitat loss, soil quality, etc. ecological changes.

Acknowledgements

The author would like to thank the editor and the anonymous reviewers for their very helpful comments and suggestions, which have allowed the manuscript to be significantly improved.

References

Ahmad, T., Hussain, M., Iqbal, M., Ali, A., Manzoor, W., Bibi, H., Ali, S., Rehman, F., Rashedi, A. and Amin, M. 2022. Environmental, energy, and water footprints of marble tile production chain in a life cycle perspective. *Sustainability* 14:8325, doi:10.3390/su14148325.

Akbulut, H. and Gürer, C. 2003. *Mermer Atıklarının Çevresel Etkileri ve Yol Katmanlarında Tekrar Kullanım imkanları,* Türkiye IV. Mermer Sempzoyumu Bildiriler Kitabı, 18-19 Aralık 2003, Afyon.

Ako, T.A., Onoduku, U.S.,Waziri, S.H., Adegbe, M., Chukwu, J.N. and Kajena, C.M. 2015. Assessment of the environmental impacts of marble quarrying on surface water at Kwakuti, Niger state, North Central Nigeria. International *Journal of Engineering and Advanced Research Technology* 1(1):64-70.

Atiyeh, M. and Aydin, E. 2020. Physical, mechanical and durability performance of pastes containing carbon fiber. *Materials* 13:1899, doi:10.3390/ma13081899.

Bilgin, Ö. and Koç, E. 2012. *Mermer Madenciliğinde Çevresel Etkiler.* 8. Uluslararası Mermer ve Doğaltaş Kongresi Bildiriler Kitabı, 13-15 Aralık 2012, 23-37, Afyonkarahisar.

Celik, M.Y. and Sabah, E. 2008. Geological and technical characterisation of Iscehisar (Afyon-Turkey) marble deposits and the impact of marble waste on environmental pollution. *Journal of Environmental Management* 87:106-116, doi:10.1016/j.jenvman. 2007.01.004.

Gabarron, M., Zornoza, R., Acosta, J.A., Faz, A. and Martinez-Martinez, S. 2019. Chapter Five-Mining environments. In: Pereira, P. (ed), *Advances in Chemical Pollution, Environmental Management and Protection*, vol 4. Elsevier, Amsterdam, pp 157-205.

Karbous, M.M., El Wahab, A.A., El Gamasy, R. and Abdellatif, M.H. 2020. Assessment of the mechanical properties of marble and granite dust-high impact polystyrene composites. *Advances in Applied Sciences* 5(3):88-96, doi:10.11648/j.aas.20200503.16.

Maponga, O. and Munyanduri, N. 2001. Sustainability of the dimension stone industry in Zimbabwe - challenges and opportunities. *Natural Resources Forum* 25:203-213.

Mehmet Akif Ersoy Üniversitesi (MAKÜ). 2012. *Burdur Gölü'nün Sorunları, Çözümleri, Yönetimi ve Ekonomik Potansiyeli*, Doğrudan Faaliyet Desteği, Proje Sonuç Raporu, Mehmet Akif Ersoy Üniversitesi, Fen-Edebiyat Fakültesi Dekanlığı, Proje Destek No: TR61-11-DFD-46, Haziran 2012, Burdur.

Noreen, U., Ahmed, Z., Khalid, A., Serafino, A.D., Habiba, U., Ali, F. and Hussain, M. 2019. Water pollution and occupational health hazards caused by the marble industries in district Mardan, Pakistan. *Environmental and Technological Innovation* 16:100470.

Ozcelik, M. 2016. Environmental pollution and its effect on water sources from marble quarries in western Turkey. *Environmental Earth Sciences* 75:796, doi:10.1007/s12665-016-5627-0.

Peñaranda Barba, M.A., Alarcón Martínez, V., Gómez Lucas, I. and Navarro Pedreño, J. 2021. Mitigation of environmental impacts in ornamental rock and limestone aggregate quarries in arid and semi-arid areas. *Global Journal Environmental and Science Management* 7(4):565-586.

Rashedi, A., Khanam, T. and Jonkman, M. 2020. On reduced consumption of fossil fuels in 2020 and its consequences in global environment and exergy demand. *Energies* 13:6048.

Singh, M,. Choudhary, K., Srivastava, A., Sangwan, K.S. and Bhuni, D. 2017. A study on environmental and economic impacts of using waste marble powder in concrete. *Journal of Building Engineering* 13:87-95, doi:10.1016/j.jobe.2017.07.009.

Stehouwer, R., Day, R. and Macneal, E. 2006. Nutrient and trace element leaching following mine reclamation with biosolids. *Journal of Environmental Quality* 35:1118-1126.

Şengün, N. and Bilgin, İ. 2022. Mermer Ocak İşletmeciliğinde Yastıklama Uygulamasının Üretim Verimine Etkisinin Araştırılması. *Süleyman Demirel Üniversitesi, Fen Bilimleri Enstitüsü Dergisi* 26(1):132-140, doi:10.19113/sdufenbed.984833.

Türkiye Cumhuriyeti Burdur Valiliği (TCBV). 2021. *Her Yönü ile Burdur*, 472 pp. ISBN: 978-605-74312-2-6.

Türkiye Cumhuriyeti Tarim ve Orman Bakanliği, Orman Genel Müdürlüğü, Isparta Orman Bölge Müdürlüğü (TCOB). 2019. *Burdur-Gölhisar havzasinin ekolojisi, ekosistemleri ve habitatlari ile mermer ocaklarinin rehabilitasyonu. (Ecology, ecosystem, habitats and rehabilitation of marble quarries of Burdur-Gölhisar Basin, NW Anatolia)*. 204 p.

Türkiye Cumhuriyeti Ticaret Bakanlığı, İhracat Genel Müdürlüğü, Maden, Metal ve Orman Ürünleri Dairesi (TCTB). 2021. *Doğal Taşlar Sektör Raporu*. 10 s. Ankara.

Türk Mühendis ve Mimar Odaları Birliği (TMMOB). 2014. *Burdur Gölü Havzası Mermer Ocakları Raporu.* 1. Baskı Haziran 2014, ISBN: 978-605-01-0623-7.

Tercan, E. and Dereli, M.A. 2021. Monitoring of Marble Quarries Expansion and Land Cover Changes Using Satellite Images and GIS on a Rural Settlement of Burdur Province, Turkey. *El-Cezerî Journal of Science and Engineering* 8(2):741-750, doi:10.31202/ecjse.868373.

Yılmaz, M. and Caran, Ş. 2019. Yarışlı Gölü (Burdur) Yakın Çevresindeki Mermer Sahalarının Jeolojik Özelliklerinin ve Çevresel Etkilerinin Araştırılması. *Sürdürülebilir Mühendislik Uygulamaları ve Teknolojik Gelişmeler Dergisi* 2(1):57-67. Retrieved from https://dergipark.org.tr/tr/pub/smutgd/issue/45823/566205.