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Derleme/Review

Ölüme Sürükleyen Mineral: Asbestin Biyoçeşitlilik ve Çevresel Sürdürülebilirlik Üzerine Etkileri / The Mineral That Leads to Death: Asbestos Impacts on Biodiversity and Environmental Sustainability

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Özet:

Asbest, ısı direnci, dayanıklılık ve yalıtım özellikleriyle bilinen, doğal olarak oluşan bir mineraldir. Yıllardır asbest, inşaat, gemi yapımı, otomotiv üretimi ve yalıtım malzemeleri gibi çeşitli endüstrilerde ve uygulamalarda yaygın olarak kullanılmaktadır. Ancak kullanımıyla tüm ekosistemi olumsuz etkilemektedir. Özellikle insan sağlığı üzerinde ciddi sağlık riskleri bulunarak insanların ölümüne bile sebep olmaktadır. Genellikle ilk maruziyetten yıllar hatta on yıllar sonra ortaya çıkar ve böylelikle asbestle ilişkili hastalıkların teşhis ve tedavisini zorlaştırır. Bu ciddi sebeplerden ötürü birçok ülke asbestin kullanımı ve üretimi konusunda katı düzenlemeler ve yasaklar getirmişlerdir. Bu da asbest kullanımını önemli ölçüde azaltmıştır. Asbeste maruz kalma tehlikelerinin farkındalığı ve çevresel sürdürülebilirlik üzerindeki olumsuz etkisini azaltmaya yönelik çabalar arasında asbestin kullanımına ilişkin daha sıkı düzenlemeler, iyileştirilmiş atık yönetimi uygulamaları ve daha güvenli alternatiflerin geliştirilmesi bireyleri asbestin zararlı etkilerinden korumaya yönelik kapsamlı düzenlemelere ve çabalara yol açmaktadır. Bu çalışmada asbest ile ilgili genel bilgilere, asbestin biyoçeşitlilik, sağlık ve çevresel sürdürülebilirlik üzerindeki etkilerine ve Türkiye ve Dünyadaki mevcut durumuna yer verilmektedir.

Anahtar Kelimeler: Asbest, Biyoçeşitlilik, Çevresel Sürdürülebilirlik, Asbest Mazuriyeti

Abstract:

Asbestos is a naturally occurring mineral known for its heat resistance, durability, and insulation properties. It is used widely in various industries and applications such as construction, shipbuilding, automotive manufacturing, and insulation materials. However, its use negatively affects the entire ecosystem. It poses serious health risks, especially to human health, and may even cause death. It often occurs years or even decades after initial exposure, making diagnosis and treatment of asbestos-related diseases difficult. For these severe reasons, many countries have introduced strict regulations and bans on using and producing asbestos. This case has significantly reduced the use of asbestos. Awareness of the hazards of asbestos exposure and efforts to reduce its negative impact on environmental sustainability include stricter regulations on the use of asbestos, improved waste management practices, and the development of safer alternatives, leading to comprehensive rules and efforts to protect individuals from the harmful effects of asbestos. This study includes general information about asbestos, its impact on biodiversity, health and environmental sustainability, and its current situation in Turkey and the world.

Keywords: Asbestos, Biodiversity, Environmental Sustainability, Asbestos Exposure

1. Introduction

Asbestos is a silicate mineral with a fibrous structure consisting of naturally occurring magnesium silicate, calcium-magnesium silicate, iron-magnesium silicate, and complex sodium-iron silicate (Atabey, 2014). Asbestos is also known by names such as 'asbestos, White soil, ' and ' barren' among the public. Asbestos is a good insulation material; its use began in ancient times. In light of the information obtained from archaeological studies, it is known that the use of asbestos dates back 2500 years. After the second half of the nineteenth century, asbestos began to be recognized as a magic mineral because it insulated heat and electricity and was resistant to friction and acids. After the second half of the twentieth century, asbestos was defined as lethal dust when it was determined to be a carcinogenic substance that caused severe harm to human health (Wikipedia, 2021). Asbestos causes death and is divided into the amphibole and serpentine groups regarding mineralogical properties.

1.1.Amphibole Group:

It contains magnesium, sodium, calcium silicate, and iron in its fiber structure. They have a complicated and needle-like system. Asbestos in this group includes amosite (brown asbestos), crocidolite (blue asbestos), tremolite (White amphibole), actinolite, etc. The types of asbestos are the most harmful (Figure 1).

Figure 1: Amphibole group asbestos (Arslantaş, 2018; ÇSGB, 2019; Metin, 2019)

1.2. Serpentine Group:

Its fibers have a silky, twisted, flexible, and durable structure. Asbestos in this group consists of chrysotile (white asbestos), lizardite, and antigorite minerals (Figure 2).

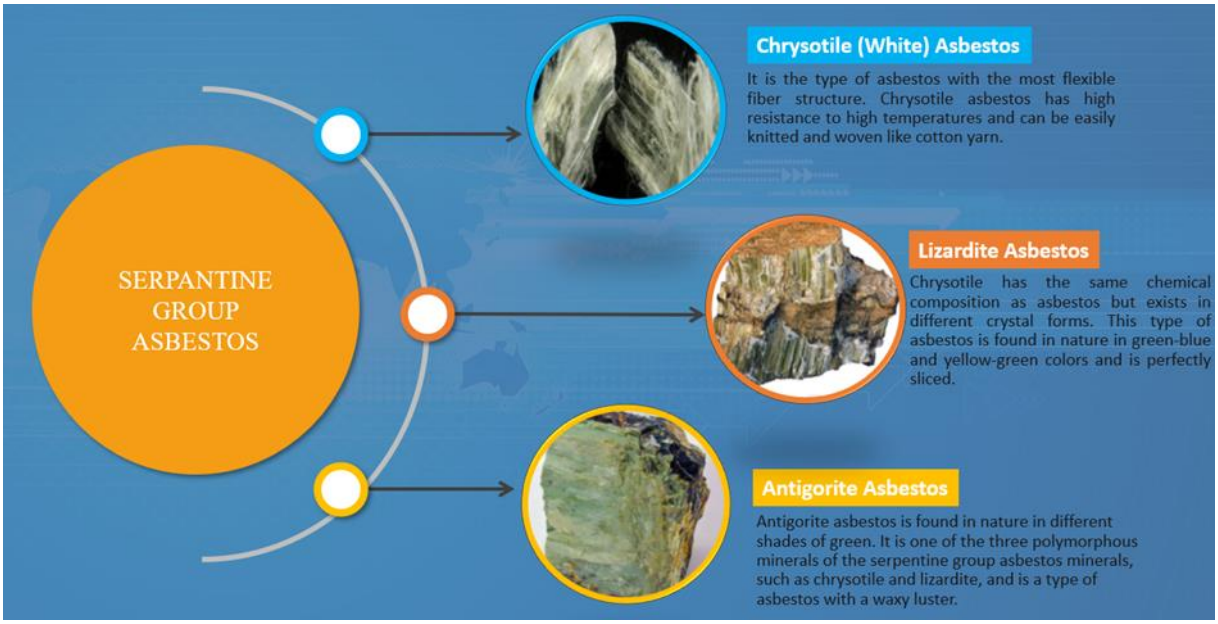

Figure 2: Serpentine group asbestos (Arslantaş, 2018; ÇSGB, 2016)

Considering the physicochemical properties of asbestos, The most distinctive feature of asbestos types is that they do not burn efficiently. In addition, the fibers can remain intact at very high

temperatures. However, asbestos cannot be used as a refractory (break-resistant) material. Once decomposed, it cannot resist pressure. When exposed to high heat at a specific temperature, the fibers deteriorate and lose their fundamental physical properties. This varies depending on the type and type of asbestos, its chemical composition, and other minerals involved. As a result, choosing the type of fiber that will achieve the expected use of the material to be produced is very important (Badollet, 1948; Emiroğlu, 2006).

In addition to its ability to withstand high temperatures, many asbestos exhibit poor conductivity. When its iron content is low, it is suitable for use as an electrical insulation material. Chrysotile, from the serpentine group, cannot conduct electricity. Asbestos fibers' low thermal conductivity is primarily due to their heat resistance and non-flammability properties. In addition to these, fiber structure is also an essential factor. The tubular fibers in the asbestos structure combine to form a cell structure with an air mass between them. Thus, unlike their low thermal conductivity coefficient, they gain insulating properties against hot and cold.

Many types of asbestos are resistant to surface conditions and decay. However, chrysotile fibers break when left in humid air and decompose when in contact with seawater. Chrysotile fibers are also unstable to acid action. When immersed in acid or caustic solutions, the fibrous structure is not affected, but a brightly colored pure silica residue is formed. On the other hand, amphibole asbestos is more resistant to chemical effects and is not affected by seawater, humid air, and gases (Badollet, 1948; Emiroğlu, 2006).

Due to its physicochemical properties, asbestos is mainly used in construction and industrial areas. Due to its severe effects on human health, its usage area has decreased, and its use, import, and export have been banned in many countries. It was used in aircraft, ships, construction, automotive, textile, chemical, and pharmaceutical industries until it was banned (Guidelines, 2013).

For example;

- Egyptians, Greeks, and Romans used it to wrap the deceased pharaohs, lamp wicks, clothes,
- In food containers, ovens, and stoves in the Bronze Age
- In the making of armor and helmets in the Middle Ages,
- In cigarette filters,
- In thermal insulation,
- In electrical insulation,
- In sound insulation,
- In decorative paints,
- Floor Tiles,
- Plate Production,

- Gasket Production,
- Used in Brake and Clutch Pads (Guidelines, 2013).

Asbestos materials have been used in buildings for many purposes, especially insulation, as they are more resistant to noise and heat. Especially in our country, structures built before 2010 often contain asbestos-containing materials. Usage areas in buildings are shown in Figure 3.

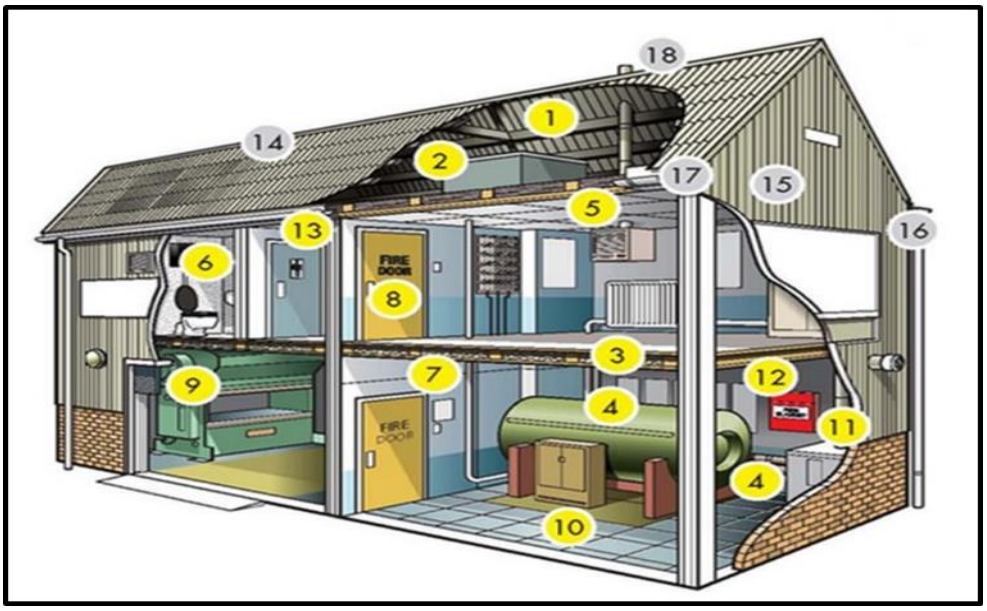

Figure 3: Areas where asbestos may be present in buildings (HSE, 2015; Üçüncü, 2022)

in Figure 3;

1. Spraying asbestos on ceilings, walls, beams and columns

2. Asbestos Cement Water Tank

3. Loose Fill Insulation

4. Coating on Boilers and Pipes

5. Ceiling Covering

6. Toilet

7. Partition Wall

8. Fire Door

9. Asbestos Ropes and Gaskets

10. Marleys and Floors

11. Asbestos Panels Around the Boiler

12. Fire Blanket

13. Decorative Coatings on Walls and Ceilings

14. Eternit (asbestos roofing material)

15. Asbestos Cement Panels

16. Asbestos Cement Gutters and Pipes

17. Upper Threshold

18. Asbestos Cement Chimney

19. Others: In fuse box, Ventilation System

Asbestos Exposure is divided into three classes: environmental asbestos, occupational asbestos, and secondary asbestos (Figure 4).

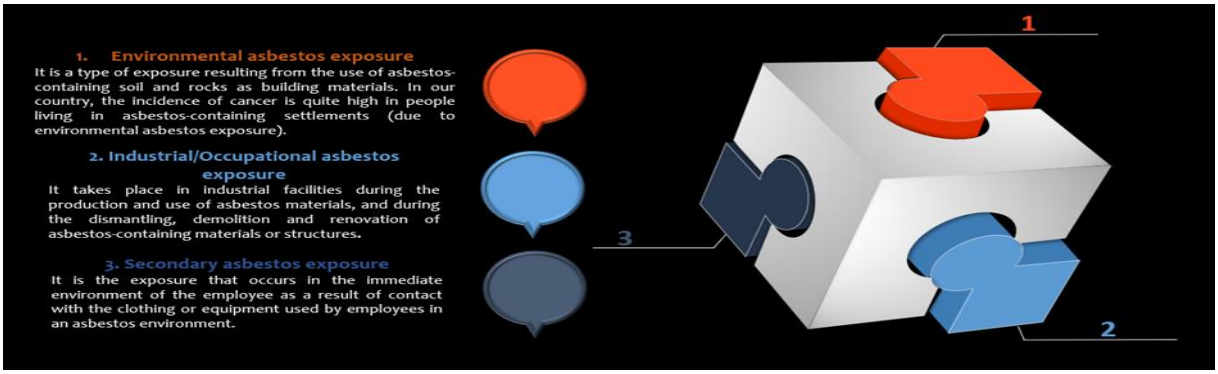

Figure 4: Types of asbestos exposure (Altıntaş, 2023)

Those living in settlements with asbestos formations in the soil structure are at risk of environmental asbestos exposure due to inhalation of asbestos fibers in the air inside or outside their homes. As an example of secondary asbestos exposure, if a father who works with asbestos materials goes home with his current clothes without taking precautions, his wife and children will be exposed to asbestos.

2. Current Situation of Asbestos in Türkiye and The World

The world's most crucial asbestos mineral deposits are in China, Russia, Kazakhstan, Canada, Brazil, and Zimbabwe. The Ural Mountains in Russia and the Appalachian Mountains in Canada and the United States are where the largest asbestos reserves are located. In Turkey, Eskişehir, Kütahya, Bilecik, Yozgat, Sivas, and Diyarbakır are the provinces where contact with asbestos is intense. The country's reserves are around 1.5-2 million tons (Kale et al. 2017; Bağcı, 2023). The distribution of asbestos mines worldwide and their direct or indirect exposure to the soil are shown in Figure 5.

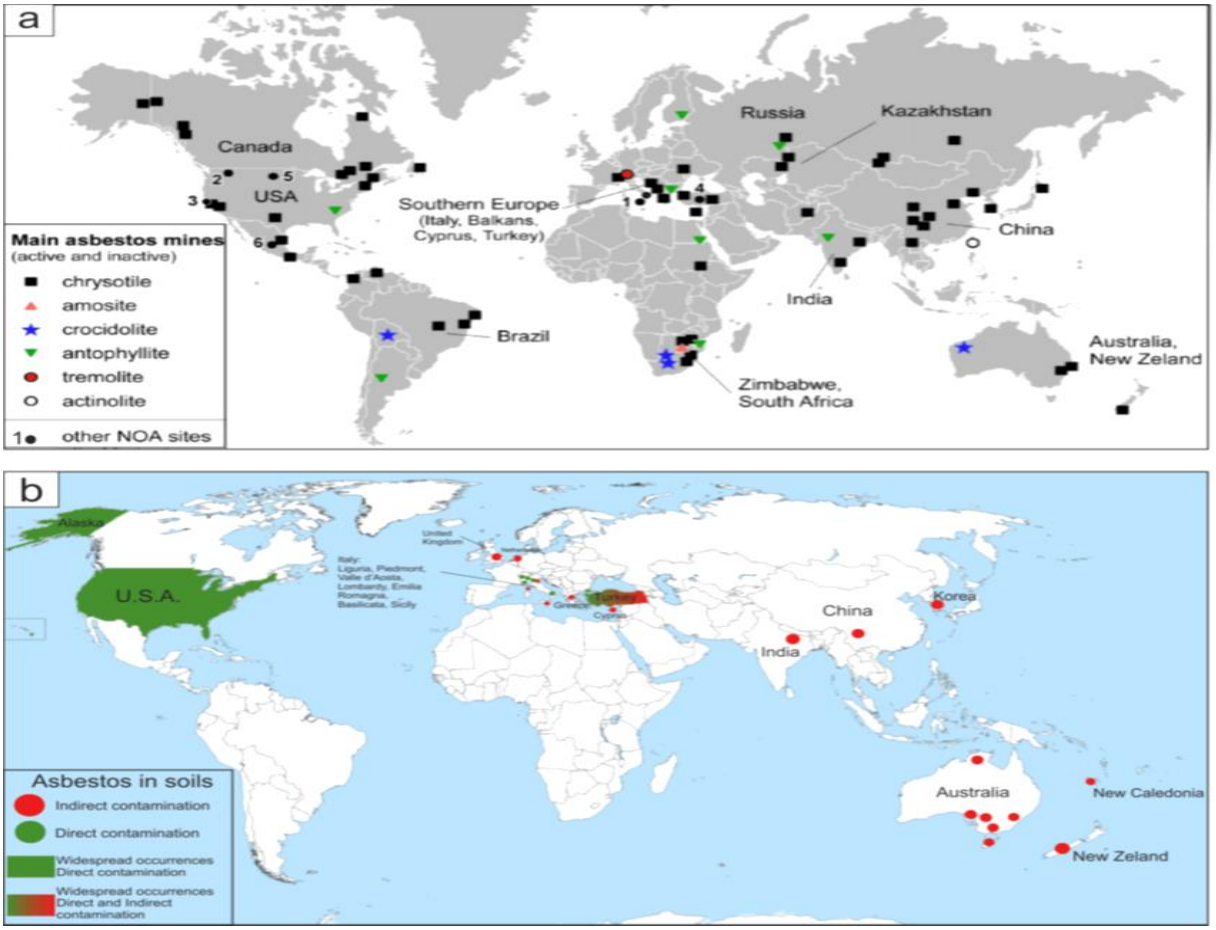

Figure 5: a) Distribution of asbestos mines in the world; b) Direct or indirect exposure to asbestos in soil (Ricchuiti et al. 2020)

Türkiye is very rich in terms of asbestos deposits. Our country is among the top 10 countries with the most asbestos deposits, with approximately 29,646,000 tons. Amphibole and chrysotile asbestos are the most common types of asbestos in our country.

At the end of the 20th century, with the ever-developing and changing technology within the scope of Occupational Health and Safety, changes have been made through legislation studies to apply in industrial areas to prevent substances harmful to human health and the environment, in short to the ecosystem, such as asbestos, which is used in industrial areas and causes exposure, to prevent harm to employees and the environment. Bans have been introduced regarding the production and use of asbestos. With these bans, asbestos production and use have decreased significantly worldwide, especially in Europe (Altıntop, 2019; Virta, 2020). 2003, the European Union published a directive 2003/18/EC. This directive prohibits all operations that expose workers to asbestos fibers during extraction, processing, and asbestos-containing production (Eur-Lex, 2020).

In 2006, WHO (World Health Organization) researched "Elimination of Asbestos-Related Diseases" and published a statement. In this declaration, it was stated that a limit threshold value could not be set for the carcinogenic effect of asbestos because there is a risk of asbestos-related cancer even at deficient exposure levels. It was stated that the most effective way to prevent diseases that may occur due to asbestos exposure would be to ban the production and use of

asbestos (Erdoğdu, 2020).

Asbestos use in Turkey continued to increase from 1980 to the 2000s. Legislation studies equivalent to the European Union directives against asbestos exposure have also been carried out in Turkey. While legislation studies have been carried out to combat asbestos exposure by introducing bans within the scope of occupational health and safety in the industrial field, a large part of the asbestos deposits in Turkey have been determined against asbestos exposure in rural areas with the "Asbestos Strategic Plan" made by scientists in our country alone (Sahan, 2015).

The "Regulation on Restrictions on the Production, Placing on the Market and Use of Certain Dangerous Substances, Preparations and Articles" published in the Official Gazette dated 29/08/2010 and numbered 27687 came into force on 31/12/2010. It removed, processed, used, and placed on the market all asbestos groups in our country. Moreover, placing products produced with asbestos on the market is prohibited. In addition, the "Regulation on Health and Safety Measures in Working with Asbestos" published in the Official Gazette No. 28539 dated 25/01/2013 was published and entered into force on the same date (Aksakal, 2021).

Regulatory measures have been implemented worldwide to control or completely ban its use. The status of asbestos regulation to date is shown in Figure 6.

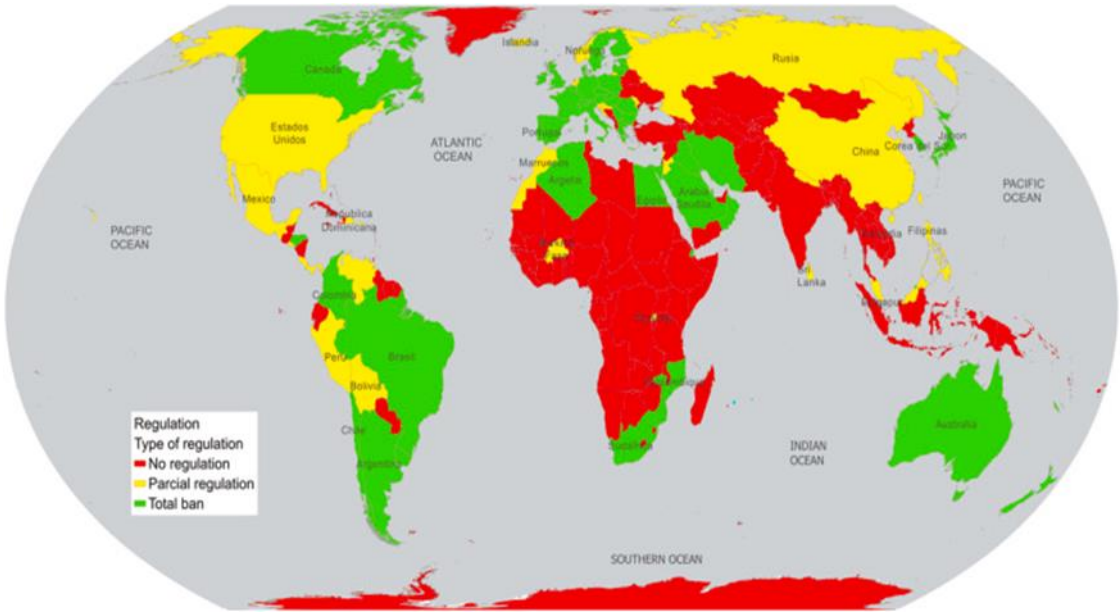

Figure 6: The latest status of the asbestos ban worldwide in 2023 (Villamizar and Camero, 2019; Thives et al. 2022)

Considering some of the countries in the world that actively use asbestos, asbestos-producing countries are also the most essential asbestos consumers. This shows that the listed countries constitute both the supply and demand sides of the market, excluding countries where asbestos is wholly or partially banned.

Waste of asbestos products is included in the hazardous waste class. Asbestos or asbestos-containing materials that produce dust should be transported in appropriate sealed packages and stored separately from other dangerous chemicals and materials. As long as wise precautions are taken in transportation and burial, no problems should arise. To ensure the management of

asbestos waste;

- Choosing appropriate waste reduction technologies,
- Establishment of regional waste processing and disposal facilities.

It is necessary to create a waste inventory on a country basis (Emiroğlu, 2006).

3. Effects of Asbestos on Biodiversity

Asbestos reaches the human body in three ways: inhalation, nutrition, and skin contact, but the effectiveness of each exposure varies. Asbestos fibers used for insulation purposes in the insulation of pipes can reach our bodies through the water used and nutrition. The intestinal mucosa ensures the retention and excretion of fibers. Asbestos-containing materials deteriorate over time, releasing microscopic asbestos fibers into the air. Asbestos fibers are not transmitted through the eyes, wounds, and skin. The most effective way of exposure is through inhalation of these fibers. Asbestos fibers show their effects directly contacting the alveoli and lung air channels. Thickening of the lung membrane, mesothelioma, asbestosis (fibrosis), and lung cancer are diseases that may occur in the lungs as a result of inhaling asbestos fibers (Güneş et al. 2017). While fibrosis (asbestosis) occurs in the lung parenchyma due to exposure to asbestos fibers for a long time and in high concentrations, pleural diseases are more common in cases of low concentration and intermittent exposure. The number of threads in the lung was lower in pleural diseases such as pleural plaque, pleural fibrosis, and malignant pleural mesothelioma (MPM) compared to asbestosis (Çöplü, 2003). The prevalence of pleural plaque in environmental asbestos exposure varies between 0.53-8%, while in occupational exposure, it varies between 3-58% (Peacock et al. 2000). This situation not only harms human health but also affects the social aspect of sustainability as it strains healthcare systems and reduces the overall well-being of affected communities.

Asbestos mining and processing activities can release asbestos fibers into the environment and contaminate soil. Chronic exposure to asbestos in soil can lead to long-term effects on soil flora, potentially affecting ecosystems' overall structure and function. Asbestos contamination can affect soil microbial communities, changing microbial diversity and activity. When plants become covered in asbestos fibers, it can inhibit their ability to photosynthesize and grow, potentially reducing habitat quality for wildlife. The impact of asbestos on soil flora (plants and microorganisms) has received less attention than its impact on human health.

For this reason, unfortunately, there is no specific scientific study on the effects of asbestos on biodiversity. Specific results may vary depending on the type of asbestos, its concentration, and the characteristics of the soil and plant species involved. Asbestos fibers can also leach into nearby water bodies, such as rivers and streams, contaminating aquatic ecosystems. This contamination can harm marine life, including fish and invertebrates, disrupting their ecological balance. Asbestos contamination can lead to cascading effects in ecosystems. For example, if a particular species' primary food source is affected by asbestos contamination, this can disrupt the entire food web, causing biomagnification. This could lead to population declines or shifts in species composition. Since there are no specific studies on the impact of asbestos on biodiversity and the long-term ecological effects, these adverse effects are currently at the point of assumption. However, researchers continue to investigate the environmental consequences of asbestos

pollution to understand its ecological impacts better.

As a result, asbestos harms environmental sustainability due to health hazards, environmental degradation during extraction, improper waste disposal, energy-intensive production, regulatory challenges, cleanup costs, and the need for sustainable alternatives. Addressing these issues through stricter regulations, responsible disposal practices, and promoting safer alternatives is crucial to minimizing the environmental impact of asbestos and moving toward a more sustainable future.

4. Results and Recommendations

1. Considering the effects of asbestos on biodiversity and environmental sustainability, various measures should be taken to reduce asbestos exposure. These measures should include using asbestos substitutes, regular inspections, and stricter legal regulations. Regarding Occupational Health and Safety, it is essential to protect the safety of employees, the environment, and the people in the background when working with asbestos. For this reason, social education and awareness programs should be carried out to understand the risks and implement protective measures.

2. Asbestos is of particular importance and poses a danger to workers during the demolition of old buildings during urban transformation works, transportation and separation or disposal of waste, and debris removal after earthquakes (Sandal et al. 2020). If precautions are not taken, asbestos may spread to the environment during these works.

3. Since asbestos materials were used in the buildings built before 2010 in our country, asbestos will be released into the environment in case of any disaster or uncontrolled demolition due to the end of the building's useful life, which will have a negative impact. Therefore, asbestos analysis should be performed.

4. One of the critical problems in asbestos in Turkey is using asbestos-containing soils for many years, especially in rural settlement areas. Using asbestos soil instead of lime in plaster and whitewash, on walls, as a floor material for side streets, as an additive to the materials used in pottery, and as children's powder and molasses soil causes asbestos-related diseases (Atabey, 2014).

5. Management of asbestos waste should be done in a controlled and reasonable manner.

6. Prohibiting asbestos, a mineral that causes death not only in our country but throughout the world, is essential to move toward a sustainable future.

7. Scientific studies are needed on the impact of asbestos on biodiversity.

8. Developed countries have public policies and a high level of awareness about asbestos pollution. Still, more research on this issue is needed in developing countries, and comprehensive studies are required in urban areas.

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article, ethics committee approval has not been obtained. Author contributions" Concept: DD, Design: DD, Supervision: DD, Literature search: DD, Writing: DD, Critical Review: DD

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