Investigation of Ecological and Economic Damages Caused by Thermal Power Plants to the Environment and Solution Suggestions

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Abstract: A significant portion of the energy consumed in Turkey is obtained from thermal power plants. Coal has the largest share among fossil fuels in electricity production. The fuels used in thermal power plants affect the environment by producing various wastes and cause air, water and soil pollution. Therefore, it causes negative effects on all living things in nature, including human health. For this reason, all countries in the world have begun to gradually abandon the use of thermal power plants, which negatively affect the environment, to obtain energy. Today, environmentally sensitive countries are turning to obtaining alternative energy with the understanding of clean production and sustainable living principles while meeting their energy needs. In this respect, in this study, thermal power plants that use coal in Turkey and the ecological and economic damage they cause to the environment were examined and solution suggestions were evaluated.

Key Words: Thermal Power Plants, Lignite, Ecological Impacts, Economic Impacts

Termik Santrallerin Çevreye Verdiği Ekolojik ve Ekonomik Zararların İncelenmesi ve Çözüm Önerileri

Özet: Türkiye'de tüketilen enerjinin önemli bölümü termik santrallerden elde edilmektedir. Elektrik üretiminde fosil yakıtlardan kömür en büyük paya sahiptir. Termik santrallerde kullanılan yakıtlar çeşitli atıklar üreterek çevrelerini etkilemekte ve hava, su, toprak kirliliklerine yol açmaktadır. Dolayısıyla da doğadaki insan sağlığı da dahil tüm canlılar üzerinde olumsuz etkilere sebep olmaktadır. Bu nedenle, tüm dünya ülkeleri tarafından çevreyi olumsuz etkileyen termik santrallerin enerji elde etmek amacıyla kullanılmasından kademeli olarak vazgeçilmeye başlanmıştır. Günümüzde çevreye duyarlı ülkeler, enerjiye olan ihtiyaçlarını karşılarken temiz üretim ve sürdürülebilir yaşam prensibi anlayışı ile alternatif enerji elde etmeye yönelmektedir. Bu açıdan çalışmada Türkiye'de özellikle kömür kullanılan termik santraller ile ekolojik ve ekonomik yönden çevreye vermiş oldukları zararlar incelenerek çözüm önerileri değerlendirilmiştir.

Anahtar Kelimeler: Termik Santraller, Linyit, Ekolojik Etkiler, Ekonomik Etkiler

1. INTRODUCTION

Nowadays, the increase in the world population and the resulting urbanization and industrialization causes the need for energy to increase. The increasing need for energy is gradually turn into a global problem. The energy problem that the world is likely to face in the future pushes societies to seek solutions to energy problems. The world tends to increase the number of power plants by using non-renewable and renewable energy sources in order to get rid of the energy bottleneck. While the power plants built to get rid of the energy bottleneck and improve the quality of life are a solution to the energy problem, they also cause some environmental problems that threaten living life (Aksan & Çelikler, 2018; Durmuş, 2011).

The most abundant fossil fuel in Turkey is lignite, which is of low quality and causes high levels of pollution. It is the backbone of the country's energy production as it is the most abundant in the country. However, the use of this type of coal creates very high amounts of sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), ozone (O_3), hydrocarbons, particulate matter (PM) and ash (Hse Türkiye, 2021).

Opening the coal reserves to energy use and starting coal-fired thermal power plants increases global climate change as well as the damage it will cause to the environment. CO_2, CH_4, N_2O released into the atmosphere as a result of burning coal and gases released into the atmosphere as a result of mining leaks have an accelerating effect on climate change (TEMA, 2014). The point climate change has reached today is entirely the product of human activities. The biggest human activity that causes climate change is electricity production processes from fossil fuels, especially coal with high carbon content. Approximately one fifth of the total greenhouse gas emissions arise from coal-fired thermal power plant activities (URL, 1).

2. THERMAL POWER PLANTS

One of the most important indicators of sophistication and development in today's world is energy production and consumption. Turkey needs

more electricity consumption due to its increasing population, developing industry and rising socio-economic structure. When we look at the history of electricity production in Turkey, the most used resources in electricity production are lignite and water (Özdemir, 2013). While the share of lignite-based thermal power plants in electricity generation was 97–98% in the first years of the Republic, this rate decreased to 94% in 1955. After this date, the ratio of thermal power plants in electricity production decreased further as a result of the succession of hydroelectric power plants coming into operation (Avcı, 2005).

Thermal power plants are systems where energy conversion takes place. The chemical energy of the fuel used in a thermal power plant is converted into heat energy, this heat energy is converted into mechanical energy, and mechanical energy is converted into electrical energy. In this transformation, lignite, hard coal, oil, natural gas and derived gases are used as fuel. Thermal power plants are steam cycle power plants (Kaçmaz & Demirpolat, 2022). They are generally built close to coal deposits (EÜAŞ, 2020). In addition to producing electricity, some thermal power plants are also used for purposes such as heat production for industrial and heating purposes and desalination of sea water (URL, 2).

Coal has the largest share as the primary energy source in electricity production in Turkey. Approximately 80% of electrical energy production is provided by thermal power plants using fossil fuels. Lignite, the most abundant domestic energy source, is consumed in many of these facilities (Bağ, 2022). Türkiye has approximately 0.85% of the world's lignite reserves; However, Turkish lignites have a low caloric value and contain relatively higher amounts of ash, moisture and sulfur. Lignite, one of the most important energy resources, has been used extensively in electricity production in Turkey since the 1950s and causes significant air pollution around thermal power plants (Say, 2006).

In addition to 29 domestic coal-fired thermal power plants, there are also imported coal-fired power plants. The country's approximately 19 billion tons of domestic lignite reserves are valuable in terms of energy production, and it is foreseen that power plant investments will continue in the coming period. However, due to the lignite mined in the country, calorific value of approximately 2000 Kcal/kg and its high sulfur content (1.38-4.65%), it requires extra precautions to be taken for the cleanliness of air and water resources and human health (EÜAŞ, 2020).

If a full capacity power plant is established where all coal will be burned for 30 years, 12.2 million tons of ash will have to be produced and disposed of in the region in return for 61 million tons of coal to be mined every year. This situation requires the hide and storage of 13.5 million tons of ash annually, if the installed power is 5870 MW. Considering that an ash dam will be established to store the ash, if this amount is accumulated only 10 meters thick, it will be necessary to open a new ash dump area the size of 174 football fields every year. At the end of the 30-year activity, there will be enough ash to fill 5.220 football fields at a height of 10 meters. In addition, fly ashes that will spread from this area to a larger area will cause thousands of hectares of agricultural or living areas to be directly affected by the ashes. In this case, the agricultural production of the region will decrease seriously (TEMA, 2014).

By the twenty-first century, developed countries have used advanced technology to reduce the environmental impacts of thermal power plants and have made some progress. However, in underdeveloped and developing countries, due to technological backwardness and lack of necessary infrastructure, thermal power plants consuming lignite have caused serious environmental problems during electricity production. Thermal power plants create significant environmental pollution through many interconnected processes, from the extraction of lignite coal to the storage of the ash created by the burned coal, and humans, animals and plants are also affected by this pollution (Goncaloğlu et al., 2000; Gürbüz & Özdemir, 2016).

3. ECOLOGICAL AND ECONOMIC DAMAGES CAUSED BY THERMAL POWER PLANTS TO THE ENVIRONMENT

Electricity production from coal brings heavy costs to the environment and human health. Pollutants from thermal power plants containing heavy metals carry this load to groundwater, rivers and lakes; thus aquatic flora and fauna are affected. Fly ash residues and waste pollute the soil, especially this pollution is very harmful and important for agricultural activities (Guttikunda & Jawahar, 2014; Karaca, 2019).

Lignite coal deposits found in Thrace in recent years have led to the development of the idea of operating thermal power plants with domestic fuel. The issue is very attractive when considered only in terms of coal/thermal power plant/electricity production. However, when the ecological and economic costs of mining, washing, burning and storing the ashes of coal are examined to the soil, underground and surface water, agriculture, forest and pasture areas, plants, animals and the final

point, human health, it becomes frightening (Boyraz Erdem, 2019).

Due to the precipitation of carbon dioxide released from the Hamitabat Thermal Power Plant in the lowlands, the average annual temperature in Lüleburgaz was 13.2 C° compared to the 1929-1970 average, and increased to 14.2 C° in the 1994-2011 period. The temperature increased by 1 C°. The reflection of this increase in the summer months is 1.7-1.9 C°. As the air warms up, the amount of evaporation also increases. Therefore, aridification requires more irrigation water in agricultural areas. When the water vapor coming from the cooling towers is added to this hot air mass coming out of the chimney, a hot air island is formed above the thermal power plant. This hot air island affects the atmospheric temperature and therefore the climate (for example, snowfall) in the region it is directed to, depending on the wind direction. Normally, as the snow slowly melts on the soil surface, water seeps deep and saturates the soil. Rainwater flows off the surface. For this reason, the temperature island in the air turning snowfall into rain is perceived as a very important climate change (Boyraz Erdem, 2019; Kantarcı, 2017).

Haktanır et al (2010), took both soil and plant samples from agricultural and forest areas (forest, 2 olive groves and 17 agricultural areas) at different distances from the Yatağan Thermal Power Plant and analyzed heavy metals. Researchers have generally determined that there are high heavy metal contents in the soils to the south, southwest and northwest of the power plant, and that these values depend on the prevailing wind directions, not the distance to the power plant.

When the excavation that will occur during mining activities is examined, the soils in the region will be seriously affected. To reach lignite, let's assume that the average topsoil thickness is 138 meters, the average thickness of the lignite coal seam is 21 m, and the depth to be excavated is 204 m. In this case, to extract every 1 m^3 of coal, approximately 9.4 m^3 of excavation must be made, and the remaining 8.4 m^3 of soil after the coal is extracted must be transferred to another place. In this case, the amount of soil excavation and excavation required to extract the entire reserve of 1.832.000.000 tons corresponds to a volume of approximately 11.5 billion m^3 and a weight of 22 billion tons. If even one thousandth of the excavation, which is excavated, removed from the quarry, stored somewhere and most of which will be filled into the pit again, becomes dust and rises into the air, this means 22 million tons of dust will fly in 30 years, or 700 thousand tons per year (TEMA, 2014).

Effects of thermal power plants on the environment; It is grouped under three main headings: air pollution caused by emissions, water pollution caused by the water used in the cooling system, and soil pollution caused by waste (URL, 3).

3.1. The Effect of Thermal Power Plants on Air Quality

Thermal power plants are the primary source of many atmospheric pollutants. One of the damages caused by thermal power plants is caused by flue gas. Considering that lignites in Turkey are rich in sulfur and radioactivity, it can be said that this problem is important for the country (Avcı, 2012: 14). When SO_2, NO and small-sized particles produced during production are transferred to the environment through the chimney, they cause serious problems on all assets (Akbay & Bilgiç, 2020: 1588; Basmacı, 2021; Charro & Pena, 2012; Dai et al., 2013). Since the fuels used in the power plant emit greenhouse gases to the O_3 layer, they negatively affect climate change and also reveal global warming problems (Karaca, 2019: 92).

Thermal power plants that use low-quality lignite as the main fuel have more polluting properties. Flue gas emissions generally affect local air quality depending on wind strength and direction (Karaca, 2019). The main pollutant emissions produced by the combustion of fuel in thermal power plants and released into the atmosphere are; They are gases such as CO_2, CO, NO_x, volatile organic compounds, SO_2, hydrocarbon species, particulate matter, CH_4 (Karaca, 2019; Kır, 2008:16). In addition to these pollutants, burning coal causes ash and heavy metals such as cadmium, mercury, lead and arsenic contained in the ash to spread into the environment and pollute it (Kır, 2008:16).

When the thermal power plant operates, small diameter particles (PM ≤ 10 µm and smaller ones, PM ≤ 2.5 µm) cannot be retained in the electrostatic filters and are released into the atmosphere with flue gases. Very fine dust and grains released into the atmosphere; Quartz and various minerals, hydrocarbons and heavy metals can enter the lungs of humans and animals and reach their brains due to their micrometric and nanometric sizes, causing various respiratory diseases and cancer. These particles prevent the respiratory pores of plants from working, enter plant cells and harm humans and animals (Kantarcı, 2017; URL, 4).

Fly ashes spread into the air with the jet and settle on the ground at certain distances from the chimney, depending on their weight and meteorological conditions. Meanwhile, the metal compounds they contain, such as Co, Cd, Zn, Pb, Cu,

can have a toxic effect on field plants or fruit trees in the receiving environment (forests, pastures, fields, etc.) on a local scale. They also have a catalytic effect on the transformation of SO_2 and NO_x gases in the jet into acid rain on a regional scale (Kaçmaz & Demirpolat, 2022; Goncaloğlu et al., 2000).

The flue gases of the thermal power plant established in Yatağan caused the red pine forests on Bencik Mountain and Sepetçi Mountain and the surrounding agricultural areas to be severely affected under the prevailing northern winds of the region. A significant decrease in increment was determined in the red pine forests that have not yet dried in the Bencik Mountain - Sepetçi Mountain area. The sulfur content in the leaves of the red pine trees in these forests is between 1.600 – 3.800 ppm, and their annual rings are very narrow. There are also significant and negative changes in the timber quality of red pine trees affected in this way.

The gases that come out of the chimneys of thermal power plants and affect the vegetation the most are SO_2 and NO_x. The most sensitive and affected organ of plants to these gases are their leaves (Anonymous, 2013; Gürbüz & Özdemir, 2016; Gümüşel & Stauffer, 2015; Kır, 2008; Ölgen & Gür, 2011). These gases, which enter the leaf structure through the stomata in the leaves, disrupt the structure of the chlorophyll in the leaf. In addition, the burning effect can also occur superficially in the form of free acid. Damages caused by pollutant effects on plants can be seen in three different dimensions. These are acute, chronic and latent harms. Plants that suffer acute damage die immediately, while chronic damage is not lethal, it greatly deteriorates plant quality. Invisible (hidden) damage emerges over time.

Apart from this direct effect of SO_2 on plants, the excess rainfall and relative humidity in the region also has an effect of increasing acidification in the soil, impoverishing bases and destroying microbiological activity, indirectly causing a decrease in the resistance of plants. This resistance weakness creates the necessary environment for the reproduction of harmful insects and fungi. These insects and fungi gradually destroy the vegetation and its quality. After the leaves, the places where SO_2 is most effective are the transmission pipes through which plant nutrients are transported. Through these pipes, the damage caused by this gas spreads to other parts of the plant. The plant cannot control transpiration and the water balance is disrupted. Wilting and drying are observed in the plant. In addition, since pollen and pistil tubes are damaged, fertilization does not occur and they cannot bear fruit. Symptoms in the fruit become apparent after the plant has been exposed to SO_2 for one year. Damages caused by thermal power plants on plants result in leaf spots, leaf drying, leaf and fruit shedding, growth regression, wilting and death.

Sulfur and nitrogen oxides discharged from chimneys are carried to the atmosphere by prevailing winds within an average of 2 - 7 days. During this time period, these pollutants react with water particles and other components in the atmosphere to form sulfuric acid and nitric acid. These reach the earth with rain and snow. Thus, flue gases affect a second time and a larger area. Depending on the terrain and weather conditions of the region, the impact can spread up to hundreds of kilometers. This phenomenon, called acid rain, poses a serious danger not only for living things, but also for stone structures and ancient works of art (Hse Türkiye, 2021).

As a result of acid rain falling on the soil, the acidity of the soil increases and these strongly acidic solutions cause the loss of minerals such as Ca^{++}, Mg^{+}, K^{+} in the soil. These minerals are vital for the growth and renewal of trees. If the pH in the soil drops below 5%, the concentration of aluminum and heavy metals in the soil liquid increases. As a result of the decrease in moisture in the soil during dry seasons, these substances become more concentrated and have a lethal effect on plant roots. In addition, SO_2 accumulated in chloroplasts prevents the leaf from performing photosynthesis and damages the tree. As a result of all these, the green shoots of the trees do not develop and dry out, their leaves fall off, and they do not bear flowers and fruits (Gürbüz & Özdemir, 2016; Hse Türkiye, 2021).

It has been reported that the reaction of soils affected by acid rain drops to 4.3 pH in some places. This is a factor that affects the nutrition of trees and facilitates their drying. Also in the surrounding villages; Olive, pistachio, fig and almond trees, vineyards, vegetable growing and tobacco, which is a common agricultural product, were severely damaged. Some of the trees dried out, and the productivity of those that did not dry out decreased by 60-80%. Tobacco, on the other hand, is not purchased because it is affected by SO_2 gas (Kesbiç et al., 2010; TTB, 2000).

Today, climate change is one of the most serious environmental issues and one of the main causes of climate change is CO_2. In developed countries, the energy sector is responsible for 90% of CO_2 emissions and 75% of total greenhouse gas emissions. Approximately half of these emissions

originate from the combustion process in power plants and refineries (Jeon et al., 2009; Karaca, 2019).

3.2. Effect of Thermal Power Plants on Water Quality

Thermal power plants built next to lakes, seas and river resources use a significant amount of water for processes such as cooling and cleaning, and this water causes thermal pollution. For this reason, choosing the place where waste water will be discharged and the temperature of the water is important (Karaca, 2019: 77).

As a result of the discharge of used water into the receiving environment, the temperature balance in the environment is disrupted. Temperature is a vital concept for living things, and temperature changes have a restrictive or even lethal effect on living activities. In order to avoid affecting the aquatic environment, it is accepted that the first rise in temperature at the exit point of the thermal discharge when it mixes with the water source should be less than 50C°. Oxygen solubility in water decreases with increasing temperature, which can harm living creatures in the aquatic environment (Karaca, 2019).

The cooling water used in thermal power plants is drawn by pumps and purified, and chemicals are added during the temporary hardness removal, precipitation and microorganism destruction stages. These chemicals used cause pollution in the receiving environment if the cooling water is released into the receiving environment. In addition, acid rain caused by pollutant gases coming out of the power plant chimney can also change the pH of the water. Heavy metals such as Fe, Mn, Co, Cu, Zn, Pb, U found in fly ashes can also reach the receiving environment via groundwater over time (Kaçmaz & Demirpolat, 2022). As a result, toxic trace elements can cause various environmental problems in both soil, surface water and groundwater (Karaca, 2019).

3.3. The Effect of Thermal Power Plants on Soil Quality

Depending on the type of coal and the way it is burned, waste may have a polluting effect (Basmacı, 2021; Sert & Yurteri, 1990: 268). The most important impact of thermal power plants on soil and water pollution comes from the ashes resulting from combustion and the gases released from the chimneys. Ashes resulting from burning in thermal power plants have negative effects on the environment during transportation and storage. Ash piles stored in open areas can be transported long distances by wind systems (Uslu, 1990). Vegetation and soil are negatively affected in the area where these ashes are stored, and if they mix with groundwater with precipitation, it causes groundwater pollution (Goncaloğlu et al., 2000; Gürbüz & Özdemir, 2016; Kaçmaz & Demirpolat, 2022).

Especially from facilities that do not have a flue gas desulfurization facility or are disabled due to malfunction, large amounts of SO_2 are released. The gas in question has many negative effects on living things. One of these is its effect on plants. As lignite-powered thermal power plants become active, there is a cumulative effect of pollutants in forests. This effect occurs as sulfur accumulation in the needle leaves of coniferous trees such as pine and a narrowing of the annual growth rings of the trees. As a result, the harmful gas effect slows down and interrupts the development of vegetation and causes loss of efficiency and revenue in wood production. A newly built thermal power plant transfers an average of 1.6 million tons of bottom ash and fly ash to the world annually. Soil pollution reduces agricultural productivity, reduces animal husbandry, and increases cancer cases in humans (URL, 5).

The type of pollution that plays an important role in the impact of thermal power plants on soil quality is mercury pollution due to its bioaccumulation properties. During the combustion process of coal containing mercury and many other trace elements, 70% of the trace elements pass into fly ashes, while almost all of them pass into fly ashes due to the evaporation of mercury at 200C°. The most important cause of mercury-related pollution, whose toxic effects are considered the most dangerous trace element that threatens human and environmental health, is coal-fired power plants with an emission rate of 52% (Karaca, 2019; Uslu & Gökmeşe, 2009).

4. EFFECTS OF COAL USED IN THERMAL POWER PLANTS ON HUMAN HEALTH

Coal-fired power plants release significant mercury into the environment, which, even at low doses, can cause minimal permanent neurological and brain damage, and at high doses can cause disability and even death. Since mercury has the most potential to harm children and unborn babies, the greatest concern in this regard is for children and pregnant women. Methylmercury is absorbed immediately when swallowed and easily passes into the brain barriers through the placenta and blood. Methylmercury decomposes very slowly and is removed from the body. Recent research has shown

that mothers' exposure to mercury during pregnancy has adverse effects on their children's speech, memory, and attention (Glick, 2001). The finding that mercury emissions from coal-fired thermal power plants in Turkey caused a total loss of 8.850 IQ points in children in 2019 revealed the effect of thermal power plants on mental retardation in children (URL, 3).

As a result of the research of the Ege University Institute of Nuclear Sciences, it was determined that the amount of radiation in 34 of 50 villages of Yatağan was well above the limits acceptable to human health. The groundwater in the areas where the ashes were thrown contains 19 times more radiation than normal. In recent years, irrigating the ash mountains, which were covered with soil and attempted to be afforested, provided some improvement, but various harmful substances contained in the ashes mixed with groundwater and harmed animals and humans through the food chain (Kesbiç et al., 2010; Keskin & Mert, 2002). Residents of Yatağan, Turgut and Yeşilbağcılar underline that asthma, bronchitis, goiter and COPD, as well as lung and laryngeal cancer, are common diseases in their villages (Gürbüz & Özdemir, 2016).

Ozone, which is emphasized by the World Health Organization and whose safe exposure level is not determined, is very dangerous for respiratory systems. Respiratory disorders such as asthma and COPD may occur or trigger attacks after exposure to ozone (Gümüşel & Stauffer, 2015).

All these risks naturally pose a greater threat to people living in areas closer to power plants. For this reason, the land of thermal power plants must be located at greater distances from human living areas. However, Afşin-Elbistan, Çan and Yatağan thermal power plants in our country contradict this statement (URL, 3).

5. THERMAL POLLUTION PREVENTION OPPORTUNITIES

Desulfurization unit (Flue Gas Desulfurization - FGD) can hold 95% of SO_2 gas. However, FGD units only retain sulfur. Other factors that harm the environment are not affected by this system. This unit converts SO_2 in the flue gas into solid substances by passing it through a solution of basic substances. Although some of these sulfur compounds can be used in the chemical or fertilizer industry, a significant solid waste problem still arises. However, the desulfurization unit is costly. For example, in 1991, the Ministry of Environment calculated that the Kemerköy Thermal Power Plant would cost 1.182 trillion liras, and the same source claimed that the desulfurization unit could be built for 1.070 trillion liras (URL, 6). Another method considered is to convert SO_2 into gypsum through various chemical processes and use these stones to make briquettes. However, gypsum is a carcinogenic substance and must be stored using special methods.

Disposal of large amounts of ash produced in thermal power plants is always a problem (URL 6). These ashes and the piles of dust accumulated in the filters are one of the most important problems created by thermal power plants. Although electrostatic filters used to retain dust and ash work 95 - 99%, the functionality of these units is questionable since the most frequently malfunctioning units of a thermal power plant are electrostatic filters and it is unclear whether production will be stopped during the malfunction. These two methods are only intended to prevent pollution caused by SO_2 and particulate matter and do not filter other wastes (such as NO_x, CO, O_3) of coal-fired thermal power plants.

It has been proven by scientists that fossil fuels are the most important cause of climate change, and Türkiye is shown as one of the regions that will be most affected by climate change. For this reason, it should abandon energy investments that accelerate climate change and turn towards sustainable, clean and renewable energy investments.

6. CONCLUSION

Many environmental problems that were not visible at the project stage have entered Türkiye's agenda with the construction of thermal power plants. Thermal power plants powered by coal; The areas where coal is mined, the power plant area, the area where coal top material is accumulated and the areas where ash is accumulated cause the destruction of the land, and therefore the irreversible destruction of agricultural, pasture and forest areas. Destroyed agricultural areas not only destroy crop growing areas, but also endanger the crops grown due to damage to surrounding lands, disruption of agricultural integrity and pollution, and therefore the health and lives of animals and people fed by these products. Lost pasture areas threaten livestock farming in that region. Limiting livestock and crop production directly affects people's nutrition. As these productions are limited, the answer to the question of what people will feed on will gradually disappear, like the destroyed lands.

Deforested forest areas and especially large pits created by coal mining areas are afforested. However, with afforestation, only various trees are planted in that area. It takes hundreds of years for an afforestation area to reach forest status. The

forest ecosystem is not an environment consisting only of trees. It is an environment that hosts all kinds of living things such as trees, all kinds of animals, all forest plants, organic material, and vegetation covering the soil surface, that is, it is an ecosystem. Damages caused to a land due to all these reasons should be calculated and evaluated as "Ecological cost".

The dependence of many local economies on the coal industry prevents Turkey from transitioning away from coal at once. A "social vulnerability analysis" conducted in December 2023 revealed that Tufanbeyli Thermal Power Plant and the coal mine that supplies coal to the power plant provide employment to 20 percent of Tufanbeyli's population. With the coal industry concentrated in many regions, local economies need to be carefully diversified. In order for the energy transition in Turkey to be fair, those who earn their living from the coal sector must be taken into account and these people must be trained and offered alternative jobs so that they can be employed in the growing renewable energy sector (URL, 2).

For the development of the region, instead of thermal power plants, projects and investment plans should be developed on the sustainability of agricultural practices. In this context, irrigated agriculture incentives should be reviewed; Farmers should be encouraged for agricultural practices compatible with the ecosystem of the region (TEMA, 2014).

Considering the negative effects of thermal power plants on the environment and people, it can be said that turning to modern resources will contribute to the solution of existing problems in today's world where technological possibilities are developing. On the other hand, the public also needs to be informed about environmental problems and developments. For this reason, the processing and presentation styles of environmental news are important as they shape the perception of the public and decision-making authorities (Basmacı, 2021).

The Paris Climate Agreement, which aims to combat climate change, has entered into force in Turkey as of 10.11.2021. Thus, Turkey has also participated in achieving the common goal of the countries that ratified the agreement, which is to keep the global temperature increase significantly below 2 degrees, limit it to 1.5 degrees if possible, and reach the carbon-neutral target throughout the planet by 2050. However, Türkiye has not yet committed to any emission reductions under the agreement. The only commitment made is the commitment to reduce the increase in greenhouse gas emissions by 18% to 21% by 2030, with the national contribution statement of intent declared in 2015 (URL, 3).

The most basic resource that will ensure the constant growth of global capital is energy. However, in meeting this need, countries need to take into account that production can also be made from renewable energy sources. Türkiye has a great potential in renewable energy production. The administration should make regulations to use this potential and not help companies maximize their profits in regulations regarding existing thermal power plants; individuals should adopt as a principle the right to live in a healthy and balanced environment (URL, 3).

The right to live in a healthy and balanced environment is guaranteed by national legislation and international agreements and is a right granted to everyone. In addition, T.C. as stated in Article 56 of the Constitution, it is a duty of the State and citizens to improve the environment, protect environmental health and prevent environmental pollution. In this context, the right to live in a healthy environment, which is one of the fundamental rights of individuals, is violated due to the scientifically proven negative effects of thermal power plants on the environment and human health (URL 3). The cost of a coal mine and thermal power plant project that will be implemented without calculating the external costs it will impose on human health and the environment will be paid not only by the population living in that region, but also by the whole of Turkey.

REFERENCES

Akbay, C., & Bilgiç, A. (2020). Afşin ve Elbistan ilçelerinde toplumun termik santrallerin çevreye ve insan sağlığına etkileri konusundaki görüşleri. Tarım ve Doğa Dergisi, 23(6), 1587-1597.

Aksan, Z., & Çelikler, D. (2018). Fen bilgisi öğretmen adaylarının nükleer ve termik santraller ile ilgili görüşleri. Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 32, 363-372.

Anonim (2013). Yıllık Rapor, Elektrik Üretim Anonim Şirketi. Ankara.

Avcı, S. (2005). Türkiye'de termik santraller ve çevresel etkileri. İstanbul Üniversitesi Edebiyat Fakültesi Coğrafya Bölümü Coğrafya Dergisi, 13, 1- 26.

Avcı, S. (2012). Türkiye'de termik santraller ve çevresel etkileri. Coğrafya Dergisi, 13, 1-27.

Bağ, F. (2022). Kömürlü termik santrallerine yönelik yürütülen çevresel etki değerlendirmesi süreçlerinin etkinliğinin artırılmasına yönelik olanakların araştırılması. Tarım, Gıda, Çevre ve Hayvancılık Bilimleri Dergisi, 3(2), 69-88.

Basmacı, G. (2021). Çevre gazeteciliği bağlamında termik santrallerle ilgili haberlerin incelenmesi. Selçuk İletişim Dergisi, 14(3), 1213-1258, Doi: 10.18094/ JOSC.938621

Boyraz Erdem, D. (2019). Kırklareli'de Termik Santral Tehlikesi. Kırklareli Dokuzhöyük Bölgesinde Önerilen

Kömürlü Termik Santralin Kurulacağı Tarım Topraklarının Tarımsal Açıdan Değerlendirilmesi. Greenpeace Akdeniz.

Charro, E., & Pena, V. (2012). Environmental impact of natural radionuclides from a coal-fires power plant in Spain. Radiation Protection Dosimetry, 153(4), 485-495.

Dai, C., Cai, X.H., Cai, Y.P., Guo, H.C., Sun, W., Tan, Q., & Huang, G.H. (2013). An integrated simulation and optimization approach for managing human health risks of atmospheric pollutants by coal-fired power plants. Journey of the Air & Waste Management Association, 64 (6), 704-720.

Durmuş, A. (2011). Enerji Üretim Yöntemleri ve Nükleer Enerji Gerçeği. Samsun Sempozyumu, 13-16 Ekim.

EÜAŞ. (2020). 2020 Yıllık Raporu.

Glick, P. (2001). The toll from coal: Power plants, emissions, wildlife and human health. Bulletin of Science, Technology & Society, 21(6), 482-500.

Goncaloğlu, B. İ., Ertürk, F., & Ekdal, A. (2000). Termik santrallerle nükleer santrallerin çevresel etki değerlendirmesi açısından karşılaştırılması. ÇEVKOR Ekoloji Çevre Dergisi, 9(34), 9-14.

Guttikunda, S.K., & Jawahar, P. (2014). Atmospheric emissions and pollution from the coal-fired thermal power plants in India. Atmospheric Environment, 92, 449-460.

Gümüşel, D., & Stauffer, A. (2015). Ödenmeyen Sağlık Faturası-Türkiye'de Kömürlü Termik Santraller Bizi Nasıl Hasta Ediyor? Sağlık ve Çevre Birliği HEAL Raporu.

Gürbüz, M., & Özdemir, Y. (2016). Afşin-Elbistan termik santrallerinin çevre kirliliği üzerindeki etkilerinin mesafe tabanlı algı analizi. Doğu Coğrafya Dergisi, 21(36), 95-118.

Haktanır, K., Sözüdoğru Ok, S., Karaca, A., Arcak, S., Çimen, F., Topçuoğlu, B., Türkmen, C., & Yıldız, H. (2010). Muğla-Yatağan Termik Santrali emisyonlarının etkisinde kalan tarım ve orman topraklarının kirlilik veri tabanının oluşturulması ve emisyonların vejetasyona etkilerinin araştırılması. Ankara Üniversitesi Çevre Bilimleri Dergisi, 2(1), 13-30.

Hse Türkiye. (2021). Termik Santraller ve Çevre, https://www.hseturkiye.net/post/termik-santraller-ve-%C3%A7evre

Jeon, E., Myeong, S., Sa, j., Kim, J., & Jeong, J. (2009). Greenhouse gas emission factor development for coal-fired power plants in Korea. Applied Energy, 87, 205-210.

Kaçmaz, Ş., & Demirpolat, H. (2022). Termik santral kaynaklı çevre kirliliğini önlemek için baca gazı arıtma teknolojisi: Örnek çalışma seyitömer termik santrali uygulaması. Avrupa Bilim ve Teknoloji Dergisi, 34, 645-651.

Kantarcı, D. (2017). Trakya'da Vize, Saray ve Çerkezköy Kömürleri ile Çalıştırılacak Termik Santralların Çevreye Yapacağı Kümülatif Etkiler Üzerine Ekolojik Bir Değerlendirme. VII. Ulusal Hava Kirliliği ve Kontrolü Sempozyumu. 683-705. Antalya.

Karaca, Z. (2019). Termik Santrallerin Çevresel Etkileri Üzerine Bir Araştırma. (Yayımlanmamış yüksek lisans tezi). Tekirdağ Namık Kemal Üniversitesi Fen Bilimleri Enstitüsü, Tekirdağ.

Kesbiç, C.Y., Baldemir, E., & İnci, M. (2010). Dışsallıkların ekonomi üzerindeki etkileri ve içselleştirilmesine ilişkin teorik yaklaşımlar-çözüm önerileri: Yatağan Termik Santrali analizi. Yönetim ve Ekonomi Araştırmaları Dergisi, 8(14), 123 – 138.

Keskin, M., & Mert, A. (2001). Türkiye'de Enerji ve Çevre Konusunda Yapılan En Büyük Hataların Bir Laboratuarı: Yatağan-Yeniköy-Gökova Termik Santralleri. TMMOB Makine Mühendisleri Odası II. Çevre ve Enerji Kongresi.

Kır, T. (2008). Afşin-Elbistan A Termik Santralinde Çalışan Kazan İşletmecilerinin Genotoksik Risklerinin Saptanması. (Yayımlanmamış yüksek lisans tezi). Kahramanmaraş Sütçü İmam Üniversitesi Fen Bilimleri Enstitüsü, Kahramanmaraş.

Ölgen, M. K., & Gür F. (2011). Yatağan Termik Santrali çevresinden toplanan likenlerde (Xanthoria parietina) saptanan ağır metal kirliliğinin coğrafi dağılışı. Türk Coğrafya Dergisi, 57, 43-54.

Özdemir, Y. (2013). Afşin-Elbistan Termik Santrallerinin Çevresel Etkileri: Mesafe Tabanlı Algı Analizi. (Yayımlanmamış yüksek lisans tezi). KSÜ Sosyal Bilimler Enstitüsü, Coğrafya Anabilim Dalı, Kahramanmaraş.

Say, N.P. (2006). Lignite-fired thermal power plants and SO2 pollution in Turkey. Energy Policy, 34(17), 2690-2701.

Sert, Y., & Yurteri, C. (1990). Kömür yakıtlı termik santrallerde başlıca çevre sorunları ve önlemler. Elektrik Mühendisliği, 376, 267-268.

TEMA (2014). Termik Santral Etkileri Uzman Raporu: Konya Kapalı Havzası (Konya - Karaman Bölgesi). https://cdn-tema.mncdn.com/Uploads/Cms/tema-vakfi-konya-kapali-havzasi-termik-santral-etkileri-uzman-raporu.pdf

TTB. (2000). Yatağan'da Hava Kirliliği'nin Değerlendirilmesi Raporu-2000. Türk Tabipler Birliği http: //www.ttb.org.tr/eweb/yatagan/index.html

URL, 1. Çevre Yükümlülüğünü Yerine Getirmeyen Termik Santraller 2019 Sonu İtibariyle Kapatılmalıdır (https://www.barobirlik.org.tr/Haberler/cevre-yukumlulugunu-yerine-getirmeyen-termik-santraller-2019-sonu-itibariyle-kapatilmalidir-80687).

URL, 2. Yükseliş ve Çöküş. Küresel Kömürlü Termik Santral Takibi. (Boom-Bust-Coal-2024-Turkish).

URL, 3. Çevre Enerji İkileminde Termik Santraller - Üstad Dergi, 21.Mart 2014. (https://ustaddergi.com.tr/cevre-enerji-ikileminde-termik-santraller/).

URL, 4. Kronik kömür kirliliği: Muğla Özel Dosyası (https://www.env-health.org/wp-content/uploads/2022/01/CC_Briefing-Turkey_Mugla_TR.pdf).

URL, 5. Termik santral – Vikipedi (https://tr.wikipedia.org/wiki/Termik_santral#:~:text=Termik%20santral%2C%20ana%20i%C5%9Fletici%20makinesi,yo%C4%9Funla%C5%9Ft%C4%B1r%C4%B1c%C4%B1da%20yo%C4%9Funla%C5%9Ft%C4%B1r%C4%B1l%C4%B1rak%20geri%20suya%20d%C).

URL 6. Termik Santraller. T.C. Çevre ve Şehircilik Bakanlığı. https://webdosya.csb.gov.tr/db/ced/editordosya/TERM%C3%84%C2%B0K%20SANTRALLER(1).pdf

Uslu, İ., & Gökmeşe, F. (2009). Termik santral kaynaklı civa kirliliği. TÜBAV Bilim Dergisi, 2(1), 10-13.