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KASTAMONU UNIVERSITY
INSTITUTE OF SCIENCE

BUFFER EFFECT OF DIFFERENT STAND STRUCTURES IN NOISE AND PARTICLE MATTER ISOLATION

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DOCTORAL THESIS
DEPARTMENT OF FOREST ENGINEERING

KASTAMONU – 2018

THESIS APPROVAL

This thesis named "**Buffer Effect Of Different Stand Structures in Noıse And Partıcle Matter Isolatıon**" that has been prepared by **Morad Farhat Musa ELFANTAZI** has been defended in front of the committee members and has been accepted as a **DOCTORAL THESIS** at Kastamonu University, Institution of Science, **Department of Forest Engineering** by **unanimous vote**.

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COMMITMENT

I declare and commit that all the information in this thesis is presented in the frame of ethical behavior and academic rules, and that this study is prepared in accordance with the thesis writing rules, and any statements and information that are not mine is fully cited to the source.

Morad Farhat Musa ELFANTAZI

ÖZET

Doktora Tezi

GÜRÜLTÜ VE PARTİKÜL MADDE İZOLASYONUNDA FARKLI MEŞCERE YAPILARININ TAMPON ETKİSİ

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Günümüzde yaşadığımız çevrenin kalitesini ve insan sağlığını olumsuz yönde etkileyen çevre kirliliklerinin başında gürültü ve hava kirliliği gelmektedir. Özellikle otoyol kenarlarında bulunan yerleşim yerleri trafikten kaynaklanan partikül madde (PM) ve gürültü kirliliğinden olumsuz yönde etkilenmektedir. Otoyollardaki PM ve gürültü kirliliğinin etkilediği alanda izolasyon görevi yapan orman örtüsünün özelliklerine göre nasıl ve ne kadar bir tampon etkisi yaptığının belirlenmesi bu çalışmanın amacını oluşturmaktadır.

Böylelikle otoyol çevresinde bulunan orman örtüsünün özelliklerine bağlı olarak yerleşim alanlarına ve yaban hayatına olumsuz etkisi olan PM ve gürültü kirliliğini orman örtüsü ile izolasyonlama kriterleri ortaya konulmuştur. Bu kriterlerinin belirlenmesi ile otoyol çevresindeki orman örtüsünün yaprak türü, kapalılık, meşcere çağı özelliklerine göre PM ve gürültü izolasyonunu sağlaması için yeterli genişlik miktarları belirlenmiştir.

Anahtar Kelimeler: Gürültü kirliliği, partikül madde, orman örtüsü, otoyol

2018, 104 sayfa
Bilim Kodu: 1205

ABSTRACT

Ph. D. Thesis

BUFFER EFFECT OF DIFFERENT STAND STRUCTURES IN NOISE AND PARTICLE MATTER ISOLATION

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Today, the major factors adversely affecting the quality of the environment where we live and human health are noise and air pollution. Especially settlements located edges of highway is adversely affected traffic caused by particulate matter and noise pollution. Purpose of this study is to determine how and how much does a buffer effect the according to characteristics of forest cover in affecting area of particulate matter and noise pollution arising in highway.

Thus, it will be presented isolation making criteria with forest cover to particulate matter and noise pollution having negative impact on residential areas and wildlife depending on the characteristics of the forest cover located around the highway. With the determination of these criteria, it will be determined the amounts of sufficient width to provide particulate matter and noise insulation according to stand age characteristics, closure, leaf type of forest cover in around the highway.

Key Words: Noise pollution, particulate matter, forest cover, highway

2018, 104 pages
Science Code: 1205

ACKNOWLEDGMENTS

Due to the consulting, guidance, sincere guidance and valuable advice he has provided during this study and also for his contribution to my development of an investigative scientist, I specifically want to express my gratitude to Assoc. Prof. Dr. Burak ARICAK.

I offer endless gratitude for the patience and encouragement of family especially for the support, encouragement and patience they have provided throughout my studies.

I wish my work to be beneficial for my country, Kastamonu and all the scientific community.

Morad Farhat Musa ELFANTAZI
Kastamonu, July, 2018

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INDEX OF ABBREVIATIONS

Al	Aluminum
As	Arsenic
Ca	Calcium
°C	Santigrat
Cd	Cadmium
CO	Carbonmonoxide
Co	Cobalt
CO^2	Carbondioxide
Cr	Chrome
Cs	Cesium
Cu	Copper
dB	Decibel
EPA	Environmental Protection Agent
F	F value
Fe	Iron
HC	Hydrocarbons
Hg	Mercury
HNO_3	Nitric asid
Hz	Hertz Point
Mg	Magnesium
Mn	Mangan
Ni	Nickel
NOX	Nitrogen oxide
O^2	Oxygen
Pb	Lead
PM	Particulate Matter
PM1	0,3 µm Particulate Matter Concentration
PM2	0,5 µm Particulate Matter Concentration
PM3	5 µm Particulate Matter Concentration
ppb	part per billion
ppm	part per million
REM	Rapid Eye Movement
SGOT	Serum Glütamik Oksalasetik Transaminaz
SGPT	Serum Glütamik Pirüvik Asit Transaminaz
SO2	Sulfur dioxide
t ha-1	ton / hectare
t yr-1	ton / year
t	ton
Zn	Zinc
µm	milimikron
µgg-1	mikrogram / gram

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1. INTRODUCTION

Today, besides the rapid increase in the world population, localization of the population in urban centers is a separate problem. While 47% (2.9 billion people) of the world's population were living in urban areas in 2000, and it is estimated that 60% of the world's population will living in urban areas by 2030 (Yüksel, 2008). More than two-thirds of the total population in European countries live in urban areas. According to the data of Turkey Statistical Institute Address-Based Population Registration System, while the proportion of residents in urban and provincial centers was 92.1% in 2015, this rate increased up to 92.3% in 2016, to %92.5 in 2017, % 7.5 of the total population has been recorded to be living in towns and villages in 2017 (URL-1). Migration continues from the village to the city, and it is estimated that the population density in urban centers will increase further (Cetin et al., 2017).

The increase in the number of people living in the cities, and therefore the increase in the number of people living in the unit area, brought many problems with it. This process causes destruction of nature, pollution of air, water and soil and destruction of ecological balance (Mutlu et al., 2013, Kulaç and Yıldız, 2016; Mutlu et al., 2016). Air pollution in the cities is one of the most important of these problems (Sevik et al., 2016).

Air and environmental pollution are factors that affect people's comfort and living conditions. Environmental pollution components which directly affect human health besides factors such as temperature, humidity, noise, light pollution and bad smell which can be detected with 5 sensory organs are mainly chemical gases, PM ratio in the air, noise etc.

The amount and duration of these contaminators are more of the main factors than their existence that determine the extent of the discomfort they cause. For example, a very high volume noise caused by a wedding and ends within a few hours is assumed less disturbing than the low volume noise of water that is constantly dripping. In this case, it is more important to remove the constant factors effecting the comfort conditions of people.

Air pollution can be defined as existence of one or more pollutants in the atmosphere in the quantity and duration that can cause damages on human, plant and animal life, commercial or personal property or the quality of the environment (Müezzinoğlu, 1987). The most common air pollution components are particulate matter (dust pollution), CO_2 and noise pollution (Sevik et al., 2016).

The most striking incident about the importance of air pollution is the one that is known as "smoggy" or "dirty mist" which occurred in 1952 in London, England. On December 5-9, 1952, about 4,000 people died in London as a result of respiratory illnesses such as pneumonia and bronchitis, and the next few months the effects of polluted air caused about 8000 more deaths (Chris Deziel, 2016). Samples from the victims showed that their lungs were contaminated by very high levels of very small particles containing heavy metals such as Pb, Zn and Fe (Shahid et al., 2017).

This incident has drawn the attention of the world public to the air pollution. Studies in this area have shown that particulate matter is a serious health hazard, especially because of the very small sizes that can be breathed as deep as the lungs and sometimes into the bloodstream (Dockery, 2009).

It has been determined that 75% of PM_2 contains elements such as Cu, Cesium, Zn, As, Cd and Pb in the gases emitted from the industrial facilities, and Pb forms 0.58% of the mass fraction in PM_1 and PM_{10} , and that Cu, Mn and Fe metals hold on PM_{10} fraction (Dubinskaya, 1998). In relation to the subject, Canepari et al. (2008) stated in their study that was conducted in Rome, Italy that heavy metals such as calcium (Ca), barium (Ba), iron (Fe), magnesium (Mg) and manganese existed in rough PM and that the heavy metals were welded of anthropogenic sources such as vehicle emissions, traffic, railway emissions. It was revealed that the > 50% of total concentration of Pb and Cd is in the fractions of <1m (Louie et al., 2005; Watson et al., 2005; Canepari et al., 2008).

These studies reveal how the particulate matter can be a great threat to human health. In recent years, the number of patients who have applied to be examined in Chest Diseases Polyclinics especially in winter has increased noticeably. In addition, frequent illnesses seen in children in winter months are considered to be due to polluted air to a certain extent. In large cities where the vehicle density is high, a sulfur dioxide (SO_2) and smoke (particulate matter-PM) pollution occurs at a noticeable level. It is an evident of how important air pollution is that, even healthy people experience health issues such as burning in the throat, headache and coughing as well as sick people in an environment with polluted air. Respiratory system disease, defined as "Metropolitan Disease", is a major health problem in cities where crowded masses live together, especially in large cities. The number of patients affected by this disease, which can be described as "Metropolitan Bronchitis", is quite large. The fact that a large number of people living in crowded cities especially children gets sick (asthma, chronic bronchitis, pneumonia, allergic disease development, frequent illness, etc.) even though they have no significant respiratory system disease is a proof of the importance of this problem (Çimen and Öztürk, 2010).

It is also known that air pollution causes acute irritation in the eyes, an increase in cardiovascular system diseases, abnormalities in nervous system development, cancer development and deaths. It affects human health as well as threatens plant and animal life and can cause water contamination (Başar et al., 2005). In addition, 70% of occupational diseases are caused by dust and toxic substances. Dust can cause significant loss of respiratory function and allergic disorders; toxic substances cause many lung disorders that have no treatment, including tissue degeneration, carcinogenic effects and premature death (Tankut et al., 2014).

The main particulate matter sources in the cities are industrial facilities and vehicles. Vehicles are also sources of pollutants other than particulate matter. Besides the particulate matter in the composition of the exhaust gases emitted from the motor vehicles using gasoline and motor, there are unburned hydrocarbons such as paraffins, olefins and aromatics; partially burned hydrocarbons (HC) such as aldehydes, ketones, carboxylic acids; carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO2) and lead compounds. 43.9% of carbon monoxide emissions, 41.0% of nitrogen oxide emissions, 26.2% of hydrocarbon emissions and 16.4% of suspended particulate matter emissions are caused by exhaust gases from motor vehicles in urban centers (Elbir et al., 2010).

Another source of pollution caused by vehicles is noise. Sounds that are not pleasant and have a negative effect on people are called noise. Especially in our metropolitan cities, the noise densities are at a very high level and they are above the measures determined by the World Health Organization. Noise have physical (temporary or permanent hearing disorders), physiological (blood pressure increase, circulatory disturbances, acceleration in respiration, slowing in heart rate, sudden reflex), psychological (behavioral disorders, extreme nervousness and stress) and performance effects (decrease in work efficiency, impairment of concentration, slowing of movements) (Toklu, 2011).

The duration of exposure to the noise and the severity of the noise also affect the damage of it on people. Researches conducted in the field of in industry has shown that; when the workplace noise is reduced, job difficulty is reduced, productivity increases and work accidents are reduced. According to the Ministry of Labor and Social Security, 10% of the occupational diseases were detected as hearing loss caused by the noise. Although many occupational diseases can be treated, hearing loss cannot be treated (Toklu, 2011).

According to a survey conducted in Germany, 47% of the disturbing noise sources is of traffic noise. The total share of motor vehicle-induced noise is 73% of total (Toklu, 2011).

The noise generated by the use of vehicles in traffic is usually the noise caused by the engines of the vehicles due to the exhaust and the suspension. The traffic noise varies depending on the power of the engine, its speed, type of the vehicles traveling, the road gradients and the pavement characteristics. Because of the traffic noise generated by all these reasons, it creates important effects both in terms of the environment and the health of the people as the traffic noise is a part of modern human life .

It is of great importance to prevent or at least to reduce pollution of particulate matter and noise caused byvehicles due to significant effects on human and environmental health. Residential areas and the wild life living near highways get adversely affected by particulate matter (PM) and noise pollution caused by highway traffic.

However, there is no detailed study on the extend and rate of insulation of forest cover that performs the insulation on the highway PM and noise pollution depending on factors such as leaf type, closeness and stand age characteristics.

The purpose of this study is to determine how and with what kind of buffer effect the forest cover, which is responsible for isolation of the area affected by PM and noise pollution on the highway, according to leaf type, closeness and stand development age characteristics. Hereby the criteria of isolation of PM and noise pollution that adversely affect the human and wild life by forest cover which is a natural buffer zone have been revealed depending on certain characteristics of the forests.

By setting these criteria, it was aimed to determine the amount of forest cover width sufficient to provide PM and noise isolation depending on the leaf type (coniferous-leafy), the stand age class (period a-b and c-d) and closeness of the forest cover around the highway.

2. LITERATURE REVIEW

Today, technological developments and industrialization have increased the need for energy, and as a result, the level of many harmful chemical substances in the atmosphere has increased and continues to increase, depending on the processing and use of petroleum, petrochemical facilities and the production and use of various chemical substances. Air pollution is increasing worldwide due to fuel, industry, energy supply and transportation means used for heating in residential areas, and air pollutant emissions in the world are estimated to increase fivefold by 2030. Rapid urbanization and increased energy consumption, especially in developing countries, have reached the level of threatening human health. It is stated that approximately 6.5 million people worldwide have lost their lives due to reasons caused by air pollution (Aslanhan, 2012; Bayram et al., 2006; Shahid et al., 2017; Isinkaralar et al., 2017, Cetin et al., 2017).

The amount and duration of these contaminators are more of the main factors than their existence that determine the extent of the discomfort they cause. For example, a very high volume noise caused by a wedding and ends within a few hours is assumed less disturbing than the low volume noise of water that is constantly dripping. In this case, it is more important to remove the constant factors effecting the comfort conditions of people.

In the 21st century world, the developing technology brought many problems with it, the factors that were not even considered in the previous century become the most important problems of our time. Light pollution, noise pollution, household waste, radioactive substances, etc. may be examples of these problems. In today's world, noise and PM pollution are the ones that should be evaluated in this context. The fact that the source of these pollutants depends on the vehicles in a significant way, the amount of traffic and the constant increase in traffic density cause the motorways to be a permanent source of PM and noise. Therefore, studies aiming solution for these problems gain importance in order to determine the extent and effects of these problems.

2.1. Particulate Matter

One of the most important parameters that make up the term air quality is the "amount of particulate matter". Particulate matter (PM) is defined as "the suspension of thin, solid or liquid particles in a gas originating from human-induced activities as a result of winds, natural sources such as volcanoes or fossil fuels burning". Particles are defined as particles in the ambient air that originate from a single molecule (about 0.002 µm in diameter) of a solid or liquid material, small physical properties of 500 µm, different in properties. PM10 (coarse particles) and PM2,5 (fine particles) represent mass of particles smaller than 10 and 2.5 µm in aerodynamic diameter, respectively. The sources and composition of PM in the nature are very complex (Özdemir et al., 2010; Yalcin, 2013).

Particulates originate from natural sources such as wind, sea, and volcanoes, or from anthropogenic sources of activity, and are suspensions of thin solid or liquid substances in a gas. It is generally referred to as aerosol in the literature (Özdemir et al., 2010).

The particle size has a direct effect on health. Particulate matter dimensions which have harmful effects on health are PM10 and PM2.5. Exposure duration to PM10 concentration negatively affects both lung and cardiac functions. People who have asthma, heart and lung diseases are more adversely affected by particulate matter pollution. In areas where there is an increase in particulate matter concentration, there are increases in hospital applications. Particulate pollution causes death of some heart and lung patients. When exposed to PM10 pollution for a short time, lung diseases get worse. Heart rate is accelerated in people with heart disease (Sivaslıgil, 2007).

The places of accumulation in the respiratory organs of the particulate matter and their existence duration in these organs are directly related to the particle size and the physical factors of the particle. The accumulation of pollutants in the alveoli is very important with the reason that there are no flickering pilars to hold particles in this region. The absence of flickering pilars makes the fine particles stay in this region for a long time. Particles smaller than 0.1 μm are moved to the air bags of the lungs by means of the Brownian move, and particles get settled in granules called alveol. Especially the particle pollution caused by thin particles causes the following problems (Sivaslıgil, 2007).

Effects of particulate matters on human health;

- Rising breathing symptoms and respiratory passage irritation, coughing or difficult breathing
- Reduced lung function
- Severe asthma
- Developing chronic bronchitis
- Non-fatal heart attacks
- Irregular heartbeat
- Pulmonary or heart diseases and premature childbirths (Sivaslıgil, 2007).

Studies have shown that every 10 μg / m3 increase in PM10 concentration causes increase 6% in daily deaths, 1% in asthma complaints and 0.5% in cardiovascular complaints, as well as causing lung diseases in people over 65 years of age (Dorjduren, 2012).

Most health effects of particulate matter are related to the effects of PM10. However, recent studies have shown that thin particles (PM2,5) can penetrate deeper into the lungs, and their accumulation in the alveoli is longer and therefore more dangerous than coarse particles in terms of health effects. However, there are also studies showing that particles dimensional between PM2,5-PM10 particles in PM10 are more toxic than PM2,5 particles and cytokine production is higher in these particles (Dorjduren, 2012).

Particulates originating from anthropogenic sources are mostly small-sized particles, which are more harmful to human health which are aerosolized by cement factories, thermal power plants, metal industries and construction activities, mining, dust from vehicles, flying ashes of coal and petroleum derivatives and agricultural activities (Scherbakova, 2010).

In the case of exposure to thin particles, the elderly, those with heart and lung diseases and children constitute risky groups. EPA reports shortened life span in elderly subjects exposed to fine particles, and increases in applications made to hospitals due to heart or lung diseases. The EPA report states that children are more susceptible to air pollution effects because air breathing rates are higher than adults, and that exposure to thin particles leads to pulmonary dysfunction and coughing disorders in children. In the same report, respiration of thin particles has been shown to trigger asthma symptoms in asthmatic patients (Dorjduren, 2012).

The adverse effects of these pollutants on health are very high because of the transport of particulate matter from the lungs to the alveoli. Examples of important disorders resulting from these adverse effects include an increase in chronic bronchitis cases, asthma, thickening of the epithelium of the respiratory tract, genetic mutation and carcinogen health problems (Scherbakova, 2010).

Particulate matters enter the body through the respiratory system. Particles have three regions in the respiratory system where they can accumulate in which are head region, the air delivery region, and the lower respiratory tract. Anatomy (air flow path shape) and air flow velocity affect the accumulation of particles. In addition, particle size, hygroscopy and solubility also affect the accumulation. Particles of between 2.5 μm and 5 μm sizes accumulate in narrower airways (bronchi) when the majority of 5 to 10 μm equivalent diameter particles are deposited in the wider airways. In the case of oral breathing, the pattern of regional accumulation changes markedly. As extrathoracic accumulation diminishes, accumulation in the bronchial tract and in the lung region increases (Dorjduren, 2012).

Some of the particulate matter that can reach the lungs can even mix into the blood. PMs containing cancerogenic organic chemicals (such as PAH, dioxin, furan) are very dangerous for health. Particulate matters, which are composed of many different compounds, are converted to acid by combining with moisture in the lungs. Long-term respiration has a risk of cancer because it contains cancerous substances such as fly ash, gasoline and diesel exhaust particles, benzo (a) pyrene (Ulutaş, 2010).

Coarse particles can worsen respiratory conditions such as asthma. Exposure to thin particles causes various adverse health effects, including premature death. Significant disorders resulting from these adverse effects include; pulmonary dysfunctions, an increase in chronic bronchitis cases, an increase in the rate of clearance of bronchial mucosa cilia, and thickening of the epithelium of the respiratory tract. Particulates cause respiratory system disorders as well as heart and circulatory system disorders. Particulate pollution is also associated with heart rhythm disorder and heart attack (Scherbakova, 2010).

Particles sized between 3 and 5 µm accumulate in both the lung and bronchial tracts, while the thin particles primarily accumulate in the lungs area when breathing through the mouth. The accumulation of larger particles (7 µm - 15 µm) is mostly in the region of the bronchial pathways. Experiments show that thin particles penetrate deeper into the lungs, while coarse particles accumulate in regions where air changes direction of airflow (Dorjduren, 2012). Most of the particles larger than 10 µm and about 60-80% of the particles between 5-10 µm are trapped in the throat and nasal region. These particles are trapped in the upper respiratory tract by sedimentation, inertia and direct impact mechanisms. Some of the PM2.5-5 are caught by the cilia at the entrance of the lungs and returned to the upper respiratory system without going down to the depths of the lungs. Silias are small fan-shaped hairs. They are constantly fluctuating and the waves may take out the particles. For this reason, a large part of the particles may return to throat (Scherbakova, 2010).

The chronic effect of particulate matter is more acute on health. When exposed to particulate contamination for a long time, there are health problems in the lung resulting by particulate accumulation. PM10 reaches up to the lungs and carbon dioxide in the blood slows down the oxygen conversion, causing breathing difficulty. In this case, the heart has to work harder in order to eliminate oxygen loss, which puts serious pressure on the heart (Ulutaş, 2010).

It takes weeks for the particles to be cleared from the lungs while it takes 24 to 28 hours to be removed from the respiratory tract. Experiments also show that the toxicity of the very thin particles in the lungs is greater. Small particles can enter the narrow zone more easily and cause inflammation to occur. Large particles may cause inflammation due to their chemical composition (Dorjduren, 2012).

In recent years, particulate matter is a serious health threat, especially for elderly and children, as well as low visibility and solar radiation balance effects (Sivaslıgil, 2007). The polluted air containing particulate matter is harmful for animals and plants similarly. Dirty air enters the pores and prevents plants from breathing. As a result, photosynthesis slows down and yet, the yield of agricultural products gets low and ripening occurs. Sulfur dioxide in particular is very damaging to grains, deterioration of the color of the leaves of trees, even in the advanced stage can cause drying. The effect of pollutants taken by foods is greater than airborne respiration. Feed crops grown in polluted areas are affected by absorption of pollutants; so that the pollutants that accumulate in the plant tissue enter the body of the animals with nutrition. Influence of animals by the pollutants indirectly affects people who feed on eating their milk, and eggs. Heavy metals such as As, Pb, Cd, Mo accumulate on the plants first in this way and reach to the animal and the human body from there (Güngör, 2013).

Particulate pollution consists of a mixture of liquid granules and solid granules in the air. The size range of the particulate matters is spread over a very wide range. Where dust, soot or smoke is composed of particles that are too dark and large in diameter that are visible to the naked eye; cloud nuclei or some toxic particles are only small enough to be seen in the electron microscope (Sivaslıgil, 2007).

The most important characteristic of the particulate matter is the particle size. The reason for this is not only that it enables to determine the aerosol source, but also the health effects, aesthetic and climatic effects (due to their light scattering characteristics). Particle size is also the most important parameter in determining the physical behavior characteristics such as the displacement of particulate matter, atmospheric existence duration, and visibility effects (Dorjduren, 2012).

By mass and composition; particles are separated into two groups as coarse particles with an aerodynamic diameter of more than 2.5 μm and small particles with an aerodynamic diameter of less than 2.5 µm (Tüncel, 2016). The aerodynamic diameter is a cubic diameter at a unit density (1 gm / cm3), which has the same velocity as the particle deposition rate (Sivaslıgil, 2007).

Thin particles contain the secondary aerosols (gas-particle conversion), combustion-generated particles, condensed organic and metal vapors. Large particles contain earth crust materials and dust given by roads and industry to the atmosphere in general. Particulate matter can be composed of many natural sources such as combustion of fuels, diesel engines, construction and industrial activities, secondary aerosols (airborne reaction of ammonia, sulfur and nitrogen oxides), plant pollen and ground dust. Particulate matter, vary widely depending on particle size, density, chemical composition and health effects potential in terms of quality and quantity (Tüncel, 2016)

Particulates with diameters less than 10 µm have a physical structure that can be carried away by the wind for kilometers. Regardless of their sources, PMs can change concentration and size with various mechanisms once they are once in the atmosphere. Sometimes it concentrates on a particle, sometimes it can evaporate through the particle. The water can make it become a cloud or fog drip with super saturation. It can also coagulate with other PMs and also take part in chemical reactions. The duration of atmospheric conditions may vary depending on the size and hygroscopic properties. Because of the moisture-like properties of soluble salts, they grow in the moist environment by taking water in and cause the solution to form droplets. Depending on their size, airborne times may vary from a few seconds to a month. For those between the size of 0.1 and 10 µm, the atmospheric existence duration can be from 1 day to several weeks (Sivaslıgil, 2007).

Particles can be formed from hundreds of different chemicals, and they spread to atmosfere in many different sizes and shapes. According to the mechanism of formation, the particulate matter can be divided into two classes. Primary particles are particles that are released directly from the source to the atmosphere. As examples of them, volcanic activities, wind blowing of the natural sources and the spreading of wood or fossil fuel burnings as a result of heat treatments may be mentioned. Secondary particles are formed by the conversion of various natural or human air pollutants (SO2, NOx, NH3) into particulates. The best example of this is the conversion of SO2 firstly to H2SO3 and subsequent reaction with NH3 to convert it to sulfate-containing particles such as (NH4)2SO4. In addition, the formation of a gas in a reaction between themselves and formation and condensation of gas in pressure medium in the form of PM, the formation of condensed products (reaction of NO2 or HNO3 with NaNO3 on sea salt particles) and the reaction of gases on the particle surfaces, and as a result of chemical reactions between the particles formation of secondary PMs are observed (Saraç, 2015).

Briefly, particles left directly in the atmosphere from a source are known as primary particles. Particles formed indirectly by some chemical reactions in the atmosphere, condensation and adsorption to the surface are called secondary particles (Sivaslıgil, 2007). In general, coarse particles consist of primary particles, whereas secondary particles contain more thin particles (Ulutaş, 2010).

It is also possible to divide PM resources into two groups as natural and human sourced (anthropogenic) at the same time (Ulutaş, 2010). Natural sourced particulate matter occurrences can usually be formed by volcanic activities, fires, windblown soil and sand, atmospheric release of volatile organic compounds by plants, oscillation of pollen or spores by plants, or by atmospheric release of sea salt particles from waves. The most common cause of particulate matter formation is anthropogenic sources. Particles formed by the in accurate purety or incomplete combustion of fossil fuels are at the top of such formations. Furthermore, in industrial production, hot steam boilers (thermal power plants), cement plants and metal industry sectors can be exemplified as anthropogenic sources (Saraç, 2015).

The content of aerosols varies according to morphological, physical and thermodynamic characteristics of them, geographical location and seasons. Particulate matter may remain in the atmosphere at long distances relative to its content and size. The active types, water-soluble types and coarse particles leave the atmosphere more quickly and they are transported by wind to a narrow area, while the thin particles can remain in the atmosphere for a long time according to the meteorological conditions and disperse the whole world troposphere. PM10 falls very slowly to the ground and can hang for long periods in the air. PM10 also affects many atmospheric processes such as cloud formation, solar radiation, and the amount of snow and rainfall. It also plays a role in cloud, rain and smoke acidification. The particulate matter also carries the task of transferring the minerals needed for the life of the creatures to distant distances (Sivaslıgil, 2007).

Particulate matter is a sink for heavy metals during the time they are in the air. Heavy metal molecules accumulate by adhering to particulate matter, and particulate matters contaminated by heavy metals is a serious threat to human health (Shahid et al., 2017).

Due to the reasons explained above, particulate matter is extremely important for human, animal and environmental health. Due to this importance, numerous studies have been carried out on particulate matter.

Due to potential health and environmental impacts, the limit values of the PM concentration in many regions of the world, including the European Union countries, are determined by regulations. Due to the dangerous effects of PM on human health and the negative effects on the environment such as climate and ecosystem, there has been an increase in PM studies in recent years. The former studies conducted on concentrations of PM2,5 and PM10 in the areas near the traffic show that the amount of concentrations reached up to critical values, but the studies performed are not sufficient (Özdemir et al., 2010).

The amount of particulate matter was studied in our country in Aydın (Başar et al., 2005) Büyükçekmece Basin (Karaca, 2008), İzmir (Doğan and Kitapçıoğlu, 2007; Yatkın and Bayram, 2007) and Malatya (Eğri et al., 1997) and various evaluations were made. The amount of particulate matter was also assessed for the city of Kastamonu. In Kastamonu, the highest mean values in seven points where the measurements were conducted indicated that there are 412,943 particles with a size of 0,3 µm, 126,300 particles with a size of 0,5 µm and 327 with a size of 5 µm. As the lowest mean values; it was determined that the number of particles with a size of

0.3 µm was 92.643, the number of particles with a size of 0.5 µm was 7633 and the number of particles with a size of 5 µm was 27. When the mean values obtained during the measurements were calculated, it was determined that there are 243.261 particles of 0.3 µm size, 34255 particles of 0.5 µm size and 102 particles of 5 µm size (Şevik et al., 2013).

As a result of the measurements conducted in Kastamonu, the highest mean values were obtained in “Telekom çıkmazı” in terms of number of particles with size of 0,3 µm (345 444) and particles with size of 0,5 µm (66 017), and “Cumhuriyet Square” in terms of number of particles with size of 5 µm . The lowest values were obtained from Daday Crossing (172 127) in terms of the number of particles with a dimension of 0,3 µm, Kışla Park (16 017) in terms of the number of particles with a dimension of 0,5 µm and Kışla Park (57), “Telekom çıkmazı” (57) Nasrullah Square (58) were measured in terms of the number of particles with a dimension of 5 µm (Şevik et al., 2013).

Despite the fact that studies on PM are quite new, many studies have been carried out on the subject because of its importance on human health. The former studies are mostly about effects of PM on human health (Valavanidis et al., 2008; Anderson et al., 2012; Davidson et al., 2005; Pope, 2000; Wiseman and Zereini, 2009; Chen and Lippmann, 2009; Harrison and Yin, 2000); and determination of the amount of PM (Chen et al., 2015; Branco et al., 2014; Kim et al., 2015; Sgrigna et al., 2016, Police et al., 2016). But the number of the studies conducted on how to reduce the pollution of particulate matter, which has a large impact on human health, is very low. An in these studies there is almost no information on what kind of material reduces the PM in which level.

2.2. Noise

In order to be able to define the definition of noise, it is necessary to define "sound" first. Sound; can be defined as the sense of small pressure fluctuations that the human ear can perceive in an elastic environment. For the formation of sound, there is a need for an audio source, an elastic medium to be subjected to pressure fluctuations, and the presence of a receiver. Sound is spread in waves. Sound from the sound source vibrates the particles of the material. For this reason, sound is spread. The more particles are compact the faster the sund is as it spread from the particle to the particle. Sound is divided into two types as physical and physiological. The sound pressure produced by the sound waves is called the sound pressure, the number of repetitions in one second of the vibration is called the Hertz number (Hz), and the speed at which the vibrations propagate at the unit time is called the sound velocity. "Noise" is a randomly structured sound spectrum that can be defined as "unwanted sound" in a subjective way (Unver, 2008).

The noise and sound are physically the same. Both noise and sound are similar acoustic waves carried on swinging particles in the air. However, the sound that is heard becomes the noise when it disturbs the people. Sound is detected by ear with a mechanical process that turns the sound waves into a vibration in the ear. In other words; sound is the mechanical vibrations that the human ear can hear. This vibrational energy comes from the physical transmission of sound from a liquid, gas, or solid medium to the air (Oruç, 2017).

Noise is not like any other environmental pollution factors. Although it spreads in the air, it is not visible like any other pollutants, it does not smell. It does not have any residues . It does not pollute the soil or the water. It's not pileup like a smelly garbage. It is not right to compare noise pollution with other environmental pollution factors. Its effects occur in small steps and insidiously. However, it is permanent and it is difficult to get rid of it (Bayraktar, 2006).

Although people like very loud sounds sometimes it has negative effects, such as many physiological and psychological disturbances, especially in hearing loss. The noise in acoustical science, which covers all areas related to sound production, propagation and perception, causes temporary or permanent damage to human health and peace. It gives people uncomfortable, disturbing feelings. Thus, these sounds which are not desired by the people are confronted as environmental noise pollution which must be controlled (Oruç, 2017).

The noise, which is an unwanted and disturbing sound, affects the wild animals negatively as well as it affects human health (Environmental Noise Measurement and Evaluation Guide, 2011). The sound pressure level unit is decibel and indicated by the symbol of "dB". The hearing limit of the human ear is 0 dB and this ratio increases logarithmically depending on the sound intensity. In general, the sound level of 120-140 dB is the pain threshold as it can differ from person to person (Oruç, 2017). Human behavior against aggression can be grouped into two groups. The first one has negative effects on the sense of hearing; psychological and physiological effects (Bayraktar, 2006). The classification for the effects on people with discomfort is given in Table 2.1.

Table 2.1. *Noise risk degrees and the effects of it on people* (Oruç, 2017).

Risk Degree / Noise Level (dBA)	**Effect**
I. Degree Noise 30-65 dBA	Disturbance, Discomfort, Feeling of restraint, Anger, Concentration and Sleep Disorder
II. Degree Noise 65-90 dBA	Heart rate change, respiratory acceleration, decreased brain pressure
III. Degree Noise 90-120 dBA	Head ache
IV. Degree Noise 120-140 dBA	Internal ear disorder
V. Degree Noise 140 < dBA	burst eardrum

According to the international standard ISO 1999 and the American National Standard ANSI S 3-1 the noise effect is classified as;
0-26 dB (A) Normal hearing,
27-40 dB (A) Very slight degree of hearing loss,
41-55 dB (A) Hearing loss at a slight degree,
56-70 dB (A) Moderate hearing loss,
71-90 dB (A) Severe hearing loss,
91-dB (A) Very advanced hearing loss (Cetin, 2000).

The effect of noise on people and even on other living things depend on the charateristics of the noise. These characteristics can be listed as:
- Noise frequency
- Exposure duration to noise
- Distribution of exposure to noise over time during the day

- Average noise level
- The total duration of exposure to noise throughout the work life
- The type of noise source and
- Age, sensitivity and environment of the person (Bayraktar, 2006).

Noise pollution has four effects on people as physical, physiological, psychological and performance effects (Bayraktar, 2006; Ögel, 2015).

The negative physical and mental effects of noise on people, cause physical loss and discomfort in short and long terms. The most common problem due to noise is the temporary loss of hearing, defined as transient hearing threshold shift (Oruç, 2017). According to a study conducted by the World Health Organization, there are 360 million people worldwide, or 5.3% of the world's population, with hearing loss Ögel, 2015).

Hearing loss can occur in various forms. Acoustic trauma is a non-reversible loss and a life-long disorder. Temporary hearing threshold change is a reduction in the hearing sensitivity of a person for a certain period of time after the noise has ceased, compared to the situation before getting affected by the noise. In temporary threshold changes, hearing loss has the chance of returning to the old condition over time. In permanent change of hearing threshold and hearing loss cannot be overcome in time, and there is no hope of recovery, turning back during a person's whole life. Permanent threshold changes are due to acute trauma or repeated, noisy, accumulating effects that have been affecting for many years (Unver, 2008). Hearing loss occurs with prolonged exposure to 85 dBA noise or short exposure to 140 dBA noise (Oruç, 2017). It is stated that hearing loss forms the 10% of occupational diseases in our country, and although permanent hearing loss cannot be treated (Bayraktar, 2006).

In case of exposure to the noise at high dB levels, noise may cause effects such as high blood pressure, palpitations, cholesterol and adrenaline increase, respiratory acceleration, muscular tension, bass pain, stomach spasms, turbulence, stress, anxiety, sudden reflexes and reactions as well as hearing loss. It is not possible to get used to noise. Even if the noise is low, it weakens the body as a result of long-lasting effect and breaks down the resistance system (Bayraktar, 2006). As a result, insomnia, increase of blood pressure, accelerated heart beat, cardiovascular diseases, hearing loss are the leading physiological effects of noise (Ögel, 2015). In addition to these, it is also stated that it can cause hormonal disorders (Erdoğan, 2016).

The human body reacts to sudden and loud voices. Today, studies and experiments are continuing on the relationship between noise and heart diseases. According to the studies it was proved that the noise can cause high blood pressure (hypertension), rapid heart beat, elevation of adrenaline, acceleration of respiration, muscle strain, irritability.

Intermittently and suddenly developing noise can cause rapid adrenaline discharge in the person, increasing the heart rate, breathing number, blood pressure; the decrease in attention and the deterioration of the sleeping order. These effects are more pronounced during sleep (Oruç, 2017).

It is indicated that noise deteriorates balance performance by affecting the vestibular system and this effect is higher when the eyes are closed (Hazar, 2017). Noise also causes vasoconstriction in the deep, dilation in the pupils, and slowing in the gastrointestinal motility. Likewise, increase in plasma cholesterol level, SGOT, SGPT levels due to noise is observed (Erdoğan, 2016).

The deterioration of sleep quality and quantity due to noise has been explored for many years. People need a healthy sleep to renew their exhausted mental and physical strength during the day (Oruç, 2017). Sleep is a function that relieves physical fatigue. Sounds up to 35 dB (A) during sleep do not affect the person. Exposure to noise more this level may cause the sleeping system to deteriorate, leading to a decline in human performance (Ünver, 2008). Sleep can be divided when exposed to a sound pressure level of 65 dBA during sleep. Various discomforts and long-term health problems may occur. According to a survey conducted in Germany, environmental noise sources were shown in the third place when asked about the reasons for sleep problems. At the same time, people who are exposed to noise calming and sleeping aids use seem to increase (Oruç, 2017). According to a survey, 25% of the European population is exposed to the noise at a level of more than 65 dBA level that affects human health negatively (Bayramoğlu et al., 2014). Acceptable top noise levels for various fields of use are given in the Table 2.2.

Table 2.2. *Acceptable top noise levels for various fields of use* (Toklu, 2011).

Usage Area	**Sound Pressure Level (Day) dBA**
Rest Areas	
Theatre and conference halls	25-30
Health Structures	
Hospital	35
Housing	
Bedrooms	35
Living Room	60
Service Parts (Kitchen, WC)	70
Educational Structures	
Classrooms, Laboratories	45
Gym, Dining Hall	60
Industrial Structures	
Factories	70-80

Vehicle noises caused by transportation cause by sudden wakes during most of the nights. Sleep is divided by sudden awakening and the sleeping time is extended again, reducing the REM (Rapid Eye Movement) sleep of the person. The effects of noise after sleep can be seen as a change in mood during awakening, a feeling of unrested, fatigue, headaches and a decrease in human performance in general (Oruç, 2017). Sleep disturbances, headaches and heart disorders increase among people who are exposed to noise (Bayraktar, 2006).

Environmental noise triggers measurable biological changes by stress response. It clearly affects sleep form and quality. These measurable effects and disturbing conditions are also reflected negatively in people's daily lives. People who are disturbed by environmental noise at night have to suffer from fatigue, discomfort, mood changes the next day due to poor sleep. At the same time, they are exposed to ongoing negativities such as prosperity and decreased cognitive performance (Oruç, 2017).

At night, noise pollution can be the most alarming aspect of health problems due to the synergistic direct and indirect (effects on biological systems via stimuli) effects. It is vital to take necessary and sufficient precautions to protect public health from this environmental noise pollution (Oruç, 2017).

Perhaps one of the most significant effects of environmental noise is the effects on human psychology. The main psychological effects of the noise are nervousness, fear, discomfort, uneasiness, fatigue, slowing in mental activities and decreasing work efficiency (Bayraktar, 2006). Psychological effects can lead to problems and depression in people, especially stress, and to prolong the healing period of patients (Ögel, 2015).

Noise directly affects people psychologically and causes psychological diseases which already exist to get worse. The negative psychological effects of environmental noises cause various behavioral disorders. Exposure to noisy atmosphere makes the condition of tension and distress permanent, which makes people uncomfortable. As a result, this exposure shows its negative effects on people as anxiety, stress, nervous disorders, distress, tension, headache, nausea, nervousness, mood changes and social conflicts. The more severe disorders are neurosis and psychosis (Oruç, 2017). It is stated that the noises between 20-30 dB disturb people psychologically (Bayraktar, 2006).

These factors which affect health negatively are called stressor agents psychiatry. Stressor agents are evaluated by being taken via the organs that receive the sight, smell, hearing, touch senses in the windows of the human being to the outside world, sent to different centers of the brain. These stressor agents, which give a sense of human distress and tension, can ruin the mental health by affecting the brain. Changes in the balance of certain bioamines in the protein structure of the brain, called mediators, cause mental disorder (Akın, 2014).

Apart from these, noise is a factor that causes performance losses. Studies show that it noise causes work mistakes and accidents in terms of work performance (Oruç, 2017). In a study conducted, it was determined that 43% of work accidents developed due to hearing loss (Erdoğan, 2016).

However, this situation varies according to the nature of the work done and the noise type. When workplace noise was reduced, work difficulty gets decreased, productivity gets increased and work accidents get decreased. (Fast, 2017). Noise at 120-130 dB can cause vertigo in normal people. Likewise, high level noise can cause work accidents by reducing visual acuity (Erdoğan, 2016).

In connection with noise, as a result of contagion of mutual speaking; listening and understanding difficulties arise, and conversations get interrupted. Communication at higher tones makes it difficult for people to communicate. Phone conversations are also affected by this. Radio, TV and music listening activities are blocked like other activities (Oruç, 2017). The people who are affected by the noise are uneasy, uncomfortable and irritable. In some cases, this disturbance and nervousness can continue even after the noise has disappeared (Akın, 2014).

Works related with memory and words negatively affected by noise as they require attention to reading and learning activities. A singing music in the background can disturb the word memory. School age requires an environment that will not conflict with children's learning health and intellectual activities. There are many scientific studies on the extent to which students are affected by environmental noise. Noise impact on schools are observed as concentration disorders and teachers to be adversely affected by this noisy environment (Oruç, 2017). Many tests reveal that high-level noise affects productivity and less mistakes are done when noise level is reduced. Mistakes occur as the direct results of mental fatigue of people that is caused by the noise which make people temperamental (Unver, 2008).

A large number of studies have been conducted on the effects of noise on human health and many studies have been conducted to determine more detailed effects of noise on human health apart from the ones mentioned above (Buxton et al., 2017; Geravandi et al., 2015; Li et al., 2016; Merchan et al., 2014) and the variation of noise level (Matějíček et al., 2006, Doygun and Gurun, 2008, Jin et al., 2014, Abbaspour et al., 2015, Fiedler and Zannin, 2015).

Noise sources are grouped into various forms. The sources that generate noises can be divided into two groups as noise inside of buildings and noise outside of buildings. These resources are also divided into groups among themselves. Noise sources can be shortly grouped as shown in Figure 2.1.

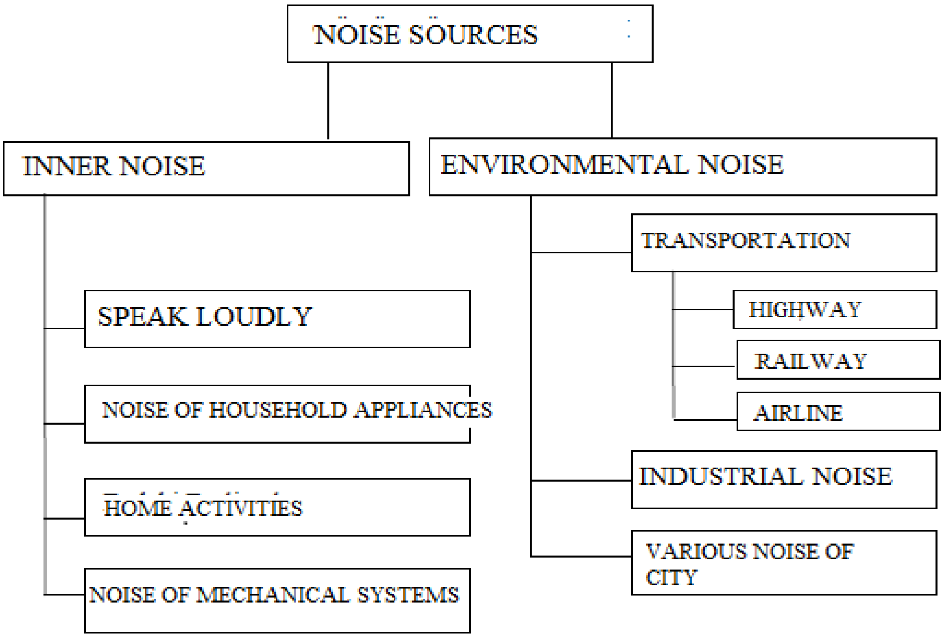

Figure 2.1. Soruces of the noise (Ünver, 2008).

Within the noise sources, the highway noise that is the subject of study has a separate precaution. According to a survey in Germany, the disturbing noise sources have a share of 47% of traffic noise. The total share of motor vehicle-induced noise is 73% (Toklu, 2011). The overall distribution of disturbing noise sources is given in the Figure 2.2.

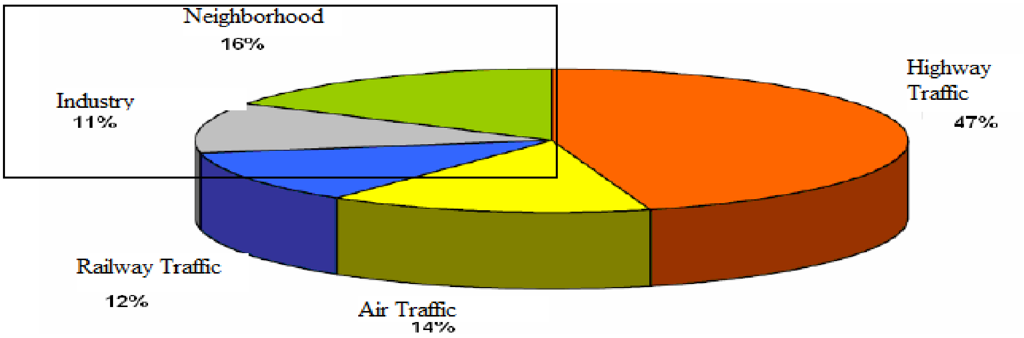

Figure 2.2. The noise sources giving discomfort (Affenzeller, 2005).

The majority of highway traffic is formed by cars and heavy vehicles. All these vehicles produce noise proportional to their strength and speed. Therefore, the noise of a moving car at than a truck with the same speed is different from each other. Similarly, the amount of noise it produces depends on the speed of the same vehicle. The amount of noise generated due to vehicle type and speed is given in the Table 2.3.

Table 2.3. *The amount of noise generated due to vehicle type and speed* (Unver, 2008).

Vehicle Type	**Speed (km/h)**	**Noise Removed dB(A)**
Single car	32	50
Single car	64	58
Single car	96	64
Single truck	40	76
Single truck	80	85

As shown in the table, when a car traveling at 32 km / h makes 50 dB (A) noise, while the same car speed is 96 km / h, the amount of noise increases to 64 dB (A). However, a truck traveling at a speed of 40 km / h per hour produces 76 dB (A) of noise.

Noise levels are legally restricted because of the effects on human health and environment. "Different sources of noise and maximum noise levels allowed to propagate from these sources" specified in Article 6/1 of the noise control regulation applied in our country are given in the Table. In accordance with the noise control regulations, it is forbidden to operate, service and use vehicles that generate higher noise than these sound levels.

Table 2.4. *Different sources of noise and maximum noise levels allowed to propagate from these sources*

Vehicle Type	Top Noise Level (dB)
Car	75
Bus (urban)	85
Bus (suburbs- rural)	80
Heavy moving vehicle (in driver's cab)	85
Truck (at 80km / h speed)	85
Locomotive (diesel engine, full power and running at full speed, speed 80 km /h and windows closed)	85
On electric trains and locomotives	80
In carriages	70

Cars, buses and trucks traveling on the highway may feel louder than the upper noise level value stated in the Table (Oruç, 2017) because the irregular, variable sound can be perceived as louder than a stable sound.

According to the highway environmental noise criteria Article 21 section "b" ; "Considering the intensity of the complaints due to the density of the population and the noise caused by the highway from the area where the highway where under three million vehicles is passing per year and the maximum environmental noise level of the roads exceeds 68 dBA during the day, effective and feasible measures must be taken by taking into account the noise screening techniques in accordance with TSEN 1793-1, TSEN 1793-2 and TSEN 1793-3 standards by the manager institution/ establishment to enable the houses not to be affected by highways; for traffic flow, highway coverage etc. on the highways and in the areas near the highways. Measures and performance tests of the effectiveness of the measures are carried out."(Regulation on the Assessment and Management of Environmental Noise (2002/49 / EC)).

Buffering the noise caused by the highway and obtaining it to be easy, aesthetic and costless, as well as ensuring its sustainability is a problem. In many countries of the world, this buffering is done with solid material, but although the material used is functional, it draws reaction of highway users because of its costs and lack of aesthetic

Perhaps the most effective method of buffering the noise caused by highway is the plant cover. Plantation is an easy, inexpensive, effective and aesthetic solution for PM and noise isolation of highway sides, for where the climate and soil conditions are suitable.

3. MATERIAL AND METHODS

The study was carried out in the areas around the roads that were selected appropriate motorways passing through the designated forest stands types within the administrative borders of Kastamonu Forest District Directorate. Within the scope of the study, PM and NP measurements were conducted on the stands on the highways with the specified characteristics. The study was conducted during April- May. Foliation had not started in measured leafy stands by the time of the measurements. Figure 3.1 shows the map of the areas where PM and NP measurements were made and Table 3.1 shows the coordinates of these areas.

Figure 3.1. The location of different stands where the PM and NP measurements were conducted (According to stand types given on Table 3.1)

Table 3.1. *The coordinates of the stand types where the PM and NP measurements were conducted*

	WGS_1984_UTM_Zone_36N Coordinates	
Stand Types	**X**	**Y**
1	4610390	571917
2	4621783	586085
3	4629230	587094
4	4625277	589057
5	4582610	562534
6	4621860	586067
7	4629190	587078
8	4596537	563782
9	4579370	558294

During the measurements, the forest areas where the road passes and which will act as a barrier were assessed separately for the eight-different terrain class which have eight different forest cover where the PM and noise measurements were conducted. In addition, nude areas with no forest cover were also designated as the ninth class to determine to which extent PM and noise were effective. Areas with different forest trails were identified by taking into consideration the types of leaves, their closeness and their age of development. The closeness, species and stands development age characteristics of determined terrain classes are given on Table 3.2.

Table 3.2. *The different forest cover classes to be used as PM and noise barrier*

Terrain Class	Closeness	Species	Stands Age
1	0	-	-
2	3-4	Leafy	a-b
3	3-4	Coniferous	a-b
4	3-4	Leafy	c-d
5	3-4	Coniferous	c-d
6	1-2	Leafy	a-b
7	1-2	Coniferous	a-b
8	1-2	Leafy	c-d
9	1-2	Coniferous	c-d

On Table 3.1, the “0” value on the closure coloumn indicates “open spaces in the forest” which are the areas with no dense forest cover or non forest cover. The value “1-2” indicates the sparse forest cover areas with a closure rate of 0-70%; and the value “3-4” indicates the dense forest cover areas with a closure rate of 70% and more. And in terms of stand age; age of a (density age) indicates youth and cultivation; the age of “b” (age of stake) indicates thin pole; and the age of “c” indicates the thin tree age and the age of “d” indicates the age of medium tree.

During the field studies, in order to get statistically meaningful results, maximum number of (at least 30) PM and noise measurements were conducted in each terrain class through which the highway passes.

The spots to conduct both PM and noise measurements were selected around the roads with as low slope as possible. The level of noise that automobiles spread around is expressed in terms of A weighted sound power level as specified in ISO 6393 standards. 100 dB sound level generated by an air horn to represent the passage of vehicles in highway in each specified terrain class;

1. On roadside (sound source)
2. 10 m from the road,
3. 25 m from the road,
4. 50 m from the road. noise measurements were made in dB (decibel) with noise level measuring devices simultaneously.

Thus, according to Article 21, section "b" of the Road Environmental Noise Criterion, the distance where the sound level has reached to the level of 68 dB at which the sound level begins to affect the human such as feeling uncomfortable, tightness, anger, concentration and sleep disturbance, and the distance where the level of sound decreases to the level of 30 dB were determined for each terrain class.

In the scope of the study, an air horn device capable of producing sound up to 100 dB level was used to represent vehicle sounds. During the noise measurement, the sound measurement device was held 1.5 m above the ground (ear-lenght). The measurements were made at daylight, in windless air, and at the 90 dB noise representing the vehicle pass, the highest value measured for 30 seconds. Air temperature and wind conditions were recorded as measurements were planned to be made in similar meteorological conditions. Wind speed is measured with anemometer and temperature is measured with thermometer. No measurement was made when the wind speed exceeded 5 m / s.

Particulate matter (3-100 micron size) was measured by spraying lime over an area of 5 m long and 2 m wide (10 m^2) along highway where each terrain class is located. Particulate matter caused by spilled lime was observed during the passage of the vehicles such as cars, buses - trucks from the highway and preliminary measurements were taken to decide which distances should be measured. The frequency of PM measurements were also determined via preliminary measurements.

Particulate matter does not move at very high speeds like the sound waves, particulate matter that is released from the ground during vehicle transit is moving away from the road at a slower speed. Therefore, the amount of particulate matter which caused by vehicle transit is moving away from the road after a certain period of time. Duration of this period was determined by preliminary measurements. During preliminary measurements, both simultaneous measurements were conducted at specific points and by observing the movement of the lime in the air the measurement spots and time were determined.

Particulate matter measurements were made in 3 different sizes (0,3 μm, 0,5 μm, 5 μm) with the Particle Counter PCE-PCO 2 brand PM measurement device. Thus, decrease range of particulate matter depending on distance was determined. The decrease amount of PM was determined separately for each terrain class.

The distances at which both the noise level and the particulate matter level fall to acceptable levels were determined via Kolmogorov-Smirnov (one sample K-S test) and Two way ANOVA testusing SPSS 22 software for each of the 9 stand types that were the cases of this study. Thus, the use of forest cover as PM and noise barriers was determined depending on leaf type (coniferous, leafy), era of stand development (a-b, c-d) and closure (1-2, 3-4). Using the obtained regression equations, the minimum widths proposed for the planning of forest cover as PM and noise barriers around the highway were determined according to eight different stand types.

3.1. Evaluation of the Data

In the study, the measurements were made in thirty repetitions for each of nine different areas for four different voice-silent distances. According to this calculation, although it was sufficient to conduct 4x9x30 = 1080 NP (noise pollution) measurements, 1164 measurements were conducted during field studies.

In determining the criteria for using the forest cover as sound insulation, it was first tried to determine the NP effect state. Accordingly, it was checked whether the measured values obtained were normal distributions. However, it was observed that the data didn't show normal distribution when checked via the "Kolmogorov-Smirnov (K-S) single sample test" ($P > 0.05$). In this situation, although nonparametric tests were considered to be applied, parametric tests have been decided to be used for interpretation of the data since parametric tests are stated to be more reliable (Batu, 1995) in large samples ($n > 30$). Statistical analyzes were conducted by the help of SPSS 22 package program.

The effect of forest cover and distance on the NP in audible measurement was revaled via "Two way analysis of variance" (Friedman). Tukey and Duncan tests were used to determine different groups if the variances were homogeneous in NP measurement.

One of the main purposed of this study was to determine in which ratio the forest cover reduced the noise amount. Therefore, the measured value at the beginning of the study was accepted as 100 units (100%) and depending on the stand type the decrease ratio of noise amount was calculated and analyzed.

The PM measurement was conducted in nine different areas for three different distances, with six repeats for each. Thus, measurements of 3x9x6 = 162 PM (Particulate Matter) were made. The data obtained from the study areas for PM and NP are given in Annex-1.

In the scope of the study, due to existence of only 2 PM measurement devices, measurements were made simultaneously from the dust source (0 m) and at 10 m distance from the road. Simultaneously, measurements were made from the side of the dust source (0 m) and the distance of 20 m from the road. The distance ranges were taken into account as (0-10, 0-20) for this study, by calculating the differences of the data obtained from both measurements to avoid the two different measurements made from the dust source (0 m).

In order to reveal the PM effect condition in determination of forest cover isolation criteria, the same analysis with NP effect condition were carried out for PM. The effect of forest cover and distance on PM was revealed by parametric tests for interpretation of PM data, according to the "Two way analysis of variance" (Friedman).

A problem occurred while interpretation of the data because the initial values of each measurement differ in the measurements made. The aim of the study was to determine the extent to which the amount of particulate matter is reduced on the basis of the particulate matter size depending on the forest cover and the distance. The results obtained for this purpose are re-evaluated, and the amount of particulate matter at the starting point is assumed to be 100 units or 100% in each measurement, and the values obtained in the measurement result are used to calculate the proportion of the dust particles to the next measurement point. With the calculations made in this way, the particulate matter size at which the amount of particulate matter decreases in relation to the forest stand structure and distance is calculated.

4. FINDINGS

4.1. Noise Pollution Measurement

According to the "Tests of Between-Subjects Effects[a]" table, while P <0.05 (according to the F test); it is seen that there is a statistically significant difference between the variables when the terrain, the distance and both are evaluated together (Table 4.1. Tests of Between-Subjects Effects). According to the results, from which groups the differences arise can be seen on Table 4.2 and Table 4.3.

Table 4.1. *Tests of Between-Subjects Effects*

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Corrected Model	307588,935[b]	35	8788,255	462,810	,000
Intercept	7081039,650	1	7081039,650	372904,167	,000
Stand	12171,737	8	1521,467	80,124	,000
Distance	270699,106	3	90233,035	4751,883	,000
Stand * distance	25844,002	24	1076,833	56,709	,000
Error	21419,478	1128	18,989		
Total	7435075,688	1164			
Corrected Total	329008,414	1163			

Table 4.2. *The effect of stand on NP values*

StandType									
NP	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Sound Mean± SE	78,89 ±0,38 b	78,43 ±0,38 b	80,98 ±0,38 c	84,08 ±0,38 d	75,11 ±0,40 a	73,73 ±0,38 a	79,35 ±0,38 bc	78,35 ±0,38 b	73,58 ±0,40 a
a,b,c,d symbols indicate the state of difference.									

Table 4.3. *The effect of distance on NP values*

Distance				
NP	**1**	**2**	**3**	**4**
Average ± Standard error	99,38±0,26^{a}	84,78±0,26^{b}	68,45±0,26^{c}	59,62±0,26^{d}
^{a,b,c,d} **symbols indicate the state of difference.**				

According to Table 4.1, when the Sig. ($p = 0.00$) value checked, it was determined that the state of forest cover is significant in audible measurement. In other words, the effect of the forest cover situation on noise pollution was found important. Apart from these, when the combined effect of forest cover and distance together on noise pollution (forest cover * distance) was evaluated, it was determined that a combined effect of these two factors ($p = 0.00$) on noise pollution can be mentioned.

When the results of the two-way " Variance Analysis Test"examined, where forest coverage and distance effects are evaluated together, it was seen that both forest cover and distance effect the noise pollution level.

In Table 4.2, when the Tukey multiple comparison test results are checked, the noise level have shown the highest mean value in the terrain with "closed mature coniferous stands" in terms of forest cover. Although there is a similarity between the average noise levels measured in “closed young leafy stands”, “semi-closed young coniferous stands” and “closed young coniferous stands” , these values are lower than the values measured in “open spaces”, “semi-closed mature coniferous stands” and “ semi-closed young leafy stands” of which the average noise level values also have a similarity between themselves. The values measured in “semi-closed mature leafy stands” and “closed mature leafy stands” were similar to each other and they had the second highest measured value.

According to Table 4.3, it was determined that there is a significant difference between the noise level averages measured at distances of 0 m, 10 m, 25 m and 50 m to the highway according to Tukey multiple comparison test results. The highest sound level average was found to be at 0 m distance to the highway (near sound source). The sound measurement averages obtained from the distances of 10 m, 25 m and 50 m are not similar to each other but lower than 0 m.

Table 4.4. *Effect of forest cover on it's own sound level*

Terrain Type									
NP	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Sound Mean±SE	48,35±0,33^{cd}	45,123±0,33a	47,59±0,33bc	46,54±0,33ab	51,09±0,34e	45,38±0,33a	46,13±0,33a	49,47±0,33d	51,33±0,34e
^{a,b,c,d} **symbols indicate the state of difference.**									

Table 4.5. *The effect of the distance on its own sound level of forest cover*

Mesafe				
GK	**1**	**2**	**3**	**4**
SoundMean±SE	48,51±0,22^{c}	47,65±0,22^{b}	50,86±0,22^{d}	44,54±0,22^{a}
^{a,b,c,d} **symbols indicate the state of difference.**				

When the results of the two-way variance test in which the effects of terrain type and distance were evaluated together on the measurement of the sound without using the horn device to measure the own voice of the forest cover, it was seen that both the terrain type and the distance were effective on own sound level of forest cover. When the results of Tukey multi-comparison test on Table 5, it is seen that the values obtained from “semi-closed young coniferous stands” and “closed young coniferous stands” have similarity and are the highest values in terms of terrain type. The mean values of noise level measured in “closed young leafy stands”, “closed mature leafy stands”, “closed mature coniferous stands, ” “closed young coniferous stands” and “semi-closed young leafy stands” has similarity to each other and are lower than the values obtained from the terrains of “open spaces”, “semi closed mature leafy stands” and “semi closed mature coniferous stands” which are also similar between each other.

When the values on Table were examined, it was determined that there is a significant difference between the mean values of sound measured from the distances of 0 m, 10 m, 25 m, 50 m and the forest cover's own sound values according to Tukey multiple comparison test results. It has been seen that the distance giving the highest sound level average is 25 m from the road. The sound measurement averages obtained from 0 m, 10 m, and 50 m distances do not show similarity with each other and are lower than the values obtained from the distance of 25 m.

Briefly, as a result of the analyzes carried out, when the noise level differences depending on the features of forest covers (coniferous- leafy, age class, closeness) are examined, it was determined that the best noise absorbing terrains were "semi-closed mature leafy stands" and "semi-closed mature coniferous stands". It was revealed with this study that the stands with semi-closed closeness absorb the noise more than the closed stands due to more sub- branching of these stands.

4.1.1. Correlation Between Stand Type and Proportional Noise Value

The variance analysis was applied to the proportionally calculated data in this way and the F value, error rate, mean results and groupings obtained by Duncan test results are given in the Table 4.6 as a result of variance analysis conducted to determine the effect of stand type on the proportional sound values.

Table 4.6. *The effect of stand type on proportional sound values*

Stand type	**Distance (m)**			
	0	**10**	**25**	**50**
Leafy	100	91,145 b	71,773 b	61,563 b
Coniferous	100	80,572 a	66,595 a	58,688 a
Open Space	100	84,673 a	66,594 a	58,530 a
F Value		20,760	20,815	5,580
Eror		,000	,000	,004

When the results on the table are examined, it is seen that the effect of stand type on sound value is statistically significant at 95% confidence level, and this effect is at

99% confidence level at 10 m and 25 m distance and 99.9% confidence level at 50 m distance. At 10 m distance, while leafy forests can reduce the sound level to 91,145% of the initial level, while coniferous forests can reduce the initial sound volume to 80,572% at 10 m distance and this ratio is calculated as 84,673% in the open spaces.

At 25 m distance, while the lowest values are obtained as 66,594% in open spaces and as 66,595% in coniferous forests, whereas this ratio is calculated as 71,773% in leafy forests. At 50 m distance, the lowest values were also obtained in open spaces and coniferous forests. As a result of the Duncan test, open-field and coniferous forests formed the first homogeneous group at all distances, while leafy forests formed the second homogeneous group. The graph which shows the effect of stand type on proportional sound values is given in Figure 4.1.

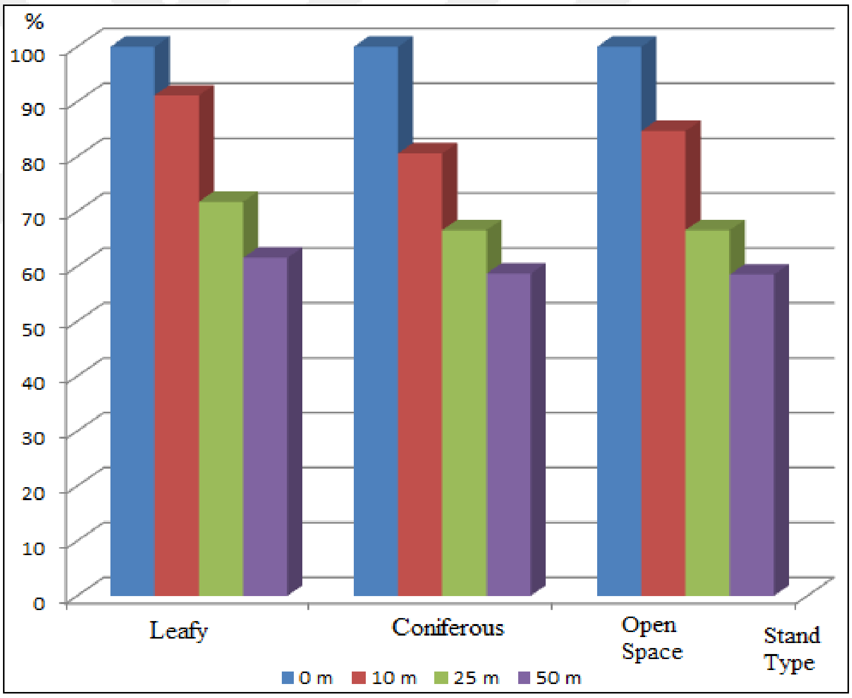

Figure 4.1. The Effect of Stand Type on Proportional Sound Values

The F value, error rate, mean values and Duncan test result groupings obtained as a result of the variance analysis applied to the data in order to determine the variation of proportional sound values depending on the closeness of stands are given in the Table 4.7.

Table 4.7. *The effect of stand closeness to the proportional sound values*

Stand Type	**Distance (m)**			
	0	**10**	**25**	**50**
Closed	100	79,807 a	67,270 a	59,010 ab
Semi-closed	100	91,909 c	71,099 b	61,241 b
Open space	100	84,673 b	66,594 a	58,530 a
F Value		31,240	12,863	4,283
Error		,000	,000	,015

As a result of the analysis of the variance, it was determined that the stand closeness affected the proportional sound values at all distances statistically significant at least at 95% confidence level, and this effect was statistically significant at 95% confidence level at 10 m and 25 m distance and at 99.9% confidence level at 50 m distance . The lowest value at 10 m was obtained in closed stands, while the highest value was obtained in semi-closed stands. The open spaces at 10 m distance, semi-closed and closed stands formed separate homogeneous groups and thus three homogenous groups were formed.

At 25 and 50 m distances, the lowest values were obtained in the open spaces. At these distances the data formed two homogenous groups, at the distance of 25m open spaces and closed stands were in the same homogenous group, and semi-closed stands were in another homogeneous group. In the distance of 50 m, the open spaces were the first, the semi-closed stands were in the second homogeneous group while the closed stands were located in both groups. The graph which shows the effect of stand closeness on proportional sound values is given in Figure 4.2.

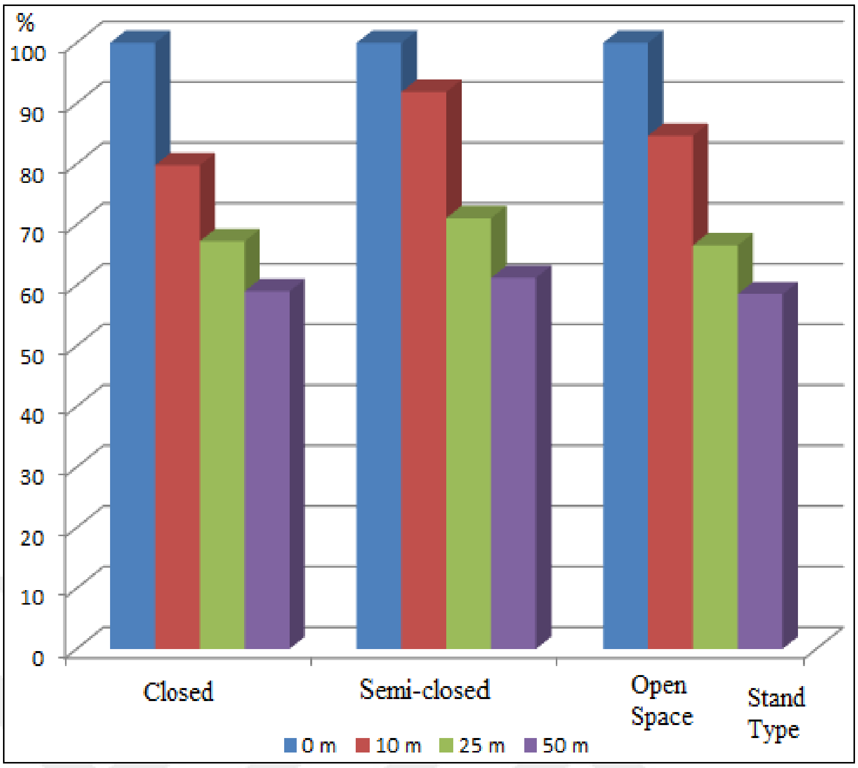

Figure 4.2. The effect of stand closeness on proportional sound values

Another factor that is thought to affect the amount of sound is the development age of stands. In the study, variance analysis and Duncan test were applied to the data to determine the effect of the stand development age on the proportional sound values, and the F value, error rate, mean values and Duncan test result groupings obtained from the applied variance analysis are given in the Table 4.8.

Table 4.8. *The effect of stand development age on proportional sound values*

Stand type	**Distance (m)**			
	0	**10**	**25**	**50**
Mature stand	100	84,128	70,252 b	63,205 b
Young stand	100	87,588	68,116 ab	57,046 a
Open Space	100	84,673	66,594 a	58,530 a
F value		2,899	4,598	28,883
Eror		,057	,011	,000

As seen on the table, it was determined that the effect of the stand development age on the proportional sound values were not statistically significant at the distance of

10 m at least at 95% confidence level, however it was found to be significant at 95% confidence level at 25 m distance and 99.9% confidence level at 50 m distance. The highest values at 25 m and 50 m were obtained at the mature stands. The graph showing the effect of stand development age on the proportional sound values is given in Figure 4.3.

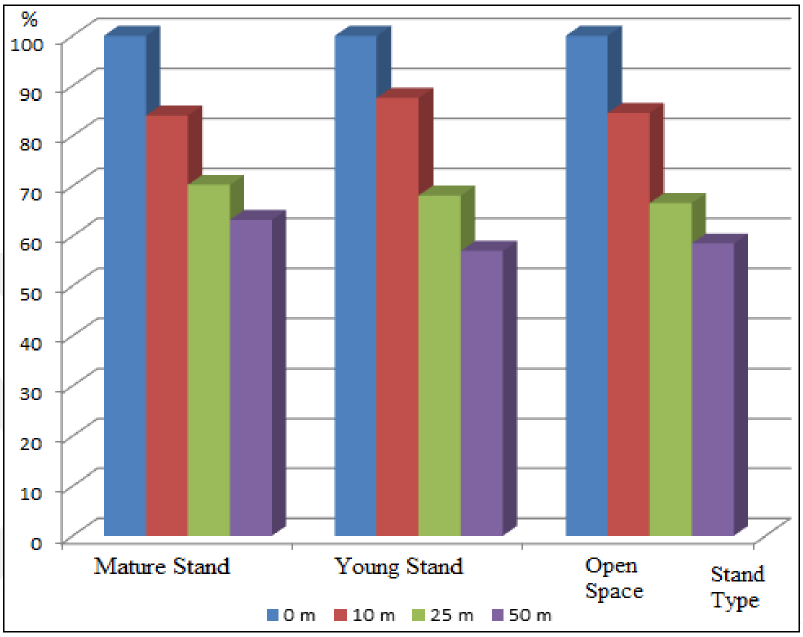

Figure 4.3. The effect of stand development age on the proportional sound values

The F value, error rate, average results and the groupings of Duncan test results were given in Table 4.9 in order to determine the ratio of the forest vegetation to the sound amount.

Table 4.9. *Proportional sound values*

Stand			**Distance (m)**			
Type	**Closeness**	**Development**	**0**	**10**	**25**	**50**
Leafy	**Semi-closed**	**young**	100	121,60 g	82,448 f	69,364 e
		mature	100	85,597 ef	72,379 d	62,612 d
	Closed	**young**	100	76,485 ab	63,973 a	51,170 a
		mature	100	80,894 c	68,294 c	63,106 d
Coniferous	**Semi-closed**	**young**	100	77,150 b	63,757 a	54,370 b
		mature	100	83,288 d	65,812 b	58,618 c
	Closed	**young**	100	75,117 a	62,287 a	53,280 b

Table 4.9 continued

		mature	100	86,733 f	74,524 e	68,485 e
Open space 1			100	84,673 de	66,594 bc	58,530 c
F Value				524,764	105,921	105,212
Eror				,000	,000	,000

When the table values are examined, it is observed that the values measured at 10, 25 and 50 m distances are statistically significant at 99.9% confidence level in terms of stand structure. Among the areas where the measurements were conducted, at only “young semi- closed leafy stands” the sound ratio was higher than the initial value. Apart from this, at all spots of measurements the sound level reduced depending on the distance. The highest values at all distances were determined in young semi-closed leafy stands.

When evaluated on the base of the distances; the lowest proportional values were obtained in “closed young coniferous stands” at the distance of 10 m. In this forest, the sound decreased to 75,117% at 10 m distance. The lowest values were obtained in “young closed coniferous stands” (62,287%), “young semi-closed coniferous stands” (63,757%) and “young closed leafy stands” (63,973%) at the distance of 25 m. At 50 m distance, the lowest value was obtained in “young closed leafy stands” with 51,170%. The variation of sound ratios depending on the stand structure at distance base is given as a graphic in the Figure 4.4.

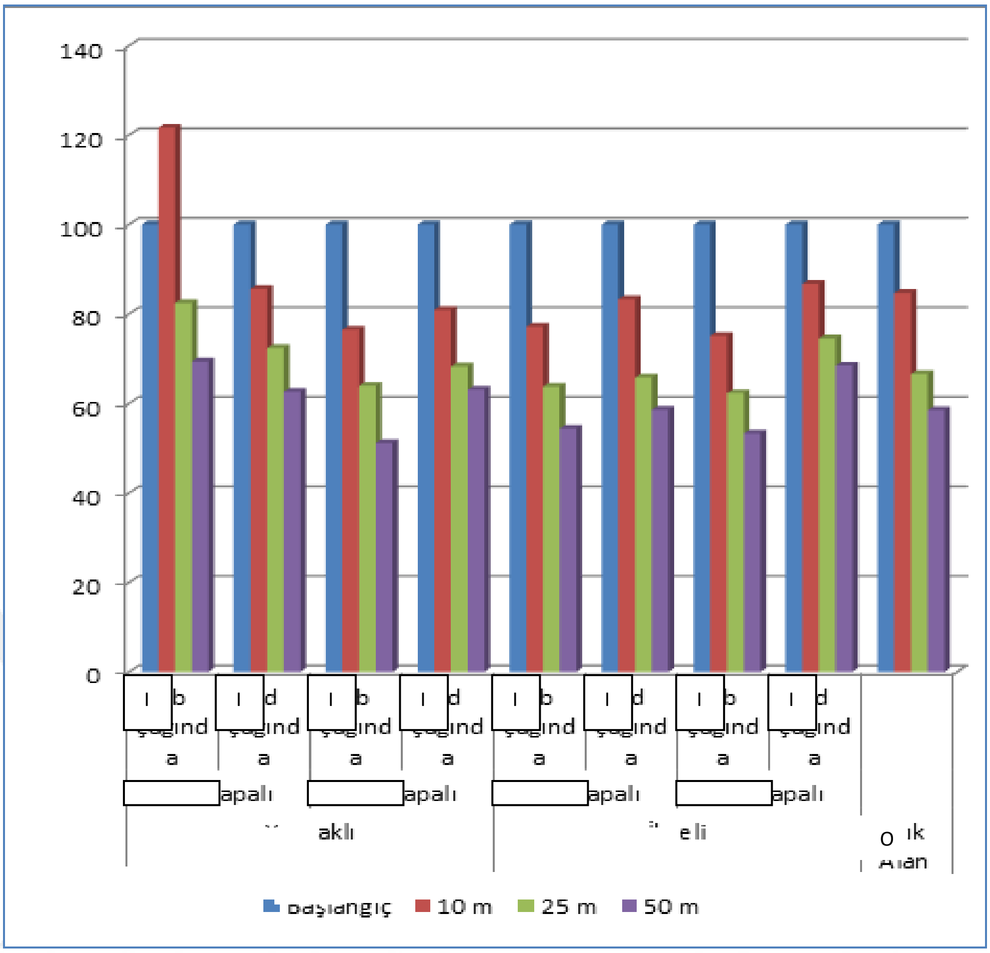

Figure 4.4. The variation of sound ratios depending on the stand structure at distance base

4.1.2. Correlation Between Stand Type and Net Sound Values

Within the scope of the study, it was determined that the forest had its own sound, except than artificially generated sound, and this sound level was determined at each measuring point in a completely silent environment. In order to determine the sound level more clearly, the sound level is calculated by subtracting the forest sound and the measured sound. In order to calculate the net sound value of the stand type, variance analysis was applied to this obtained data and the F value, error rate, average values and Duncan test result groupings obtained as the result of variance analysis were given in the Table 4.10.

Table 4.10. *The effect of stand type on net sound values*

Stand type	**Distance (m)**			
	0	**10**	**25**	**50**
Leafy	48,815 a	41,684 b	21,302 c	17,252 b
Coniferous	52,734 b	31,714 a	15,123 b	12,749 a
Open Space	51,730 b	40,579 b	12,612 a	15,760 ab
F Value	27,373	38,015	33,647	7,823
Eror	,000	,000	,000	,000

It was determined that the effect of stand type on net sound values were statistically significant at 99,9% confidence level at all distances. As a result of the Duncan test, three homogenous groups were formed at the distance of 25 m, while two homogeneous groups for each other distances were formed.

At the starting point, leafy forests formed the first homogeneous group whereas coniferous forests and open spaces formed the second homogeneous group. At 10 m distance, the coniferous forests formed the first homogeneous group, while leafy forests with open spaces were in the second homogeneous group. In the distance of 50 m, the coniferous forests were in first and the leafy forests were in the second homogeneous group. The open spaces were in both homogeneous groups.

The lowest value was obtained from open spaces and the highest value was obtained from leafy forests at the distance of 25 m, of where the data formed three homogeneous groups. The graph representing the effect of stand type on net sound values is given in Figure 4.5.

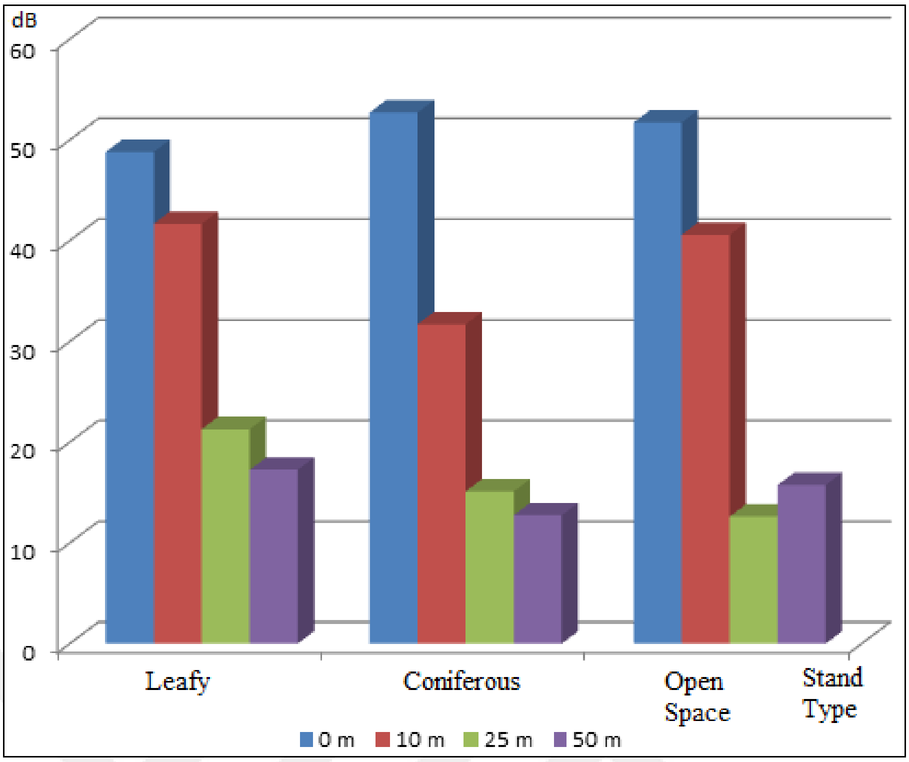

Figure 4.5. The effect of stand type on net sound values

The F value, error rate, mean values and Duncan test result groupings obtained as the result of variance analysis that was conducted to determine the effect of stand type on net sound values are given on the Table 4.11.

Table 4.11. *The effect of stand closeness on net sound values*

Stand type	**Distance (m)**			
	0	**10**	**25**	**50**
Closed	52,494 b	35,178 a	17,743 b	15,950
Semi-closed	49,056 a	38,219 ab	18,681 b	14,051
Open spaces	51,730 b	40,579 b	12,612 a	15,760
F Value	20,461	4,942	8,837	1,988
Eror	,000	,008	,000	,139

When the results of the table are examined, it is seen that the closeness of the stands effected the net sound values at all distances except the distance of 50m statistically meaningful at least at 95% confidence level, which is at 99% confidence level at 10 m distance and at 99.9% confidence level at at starting point and 25 m distance. It was determined that the closeness of stands did not effect the net sound values statistically significant at least at 95% confidence level at 50 m distance.

As a result of the Duncan test, two homogenous groups were formed at all distances and the lowest values were obtained from semi-closed stands at the starting point, closed stands at 10 m distance and open areas at 25 m distance. At the starting point, closed stand and open spaces, at 25 m distance closed and semi-closed stands constituted the second homogeneous group. At the distance of 10 m, while the open spaces formed the second homogeneous group, semi- closed stands were in both groups. The graph showing the effect of stand closeness on the net sound values is given in the Figure 4.6.

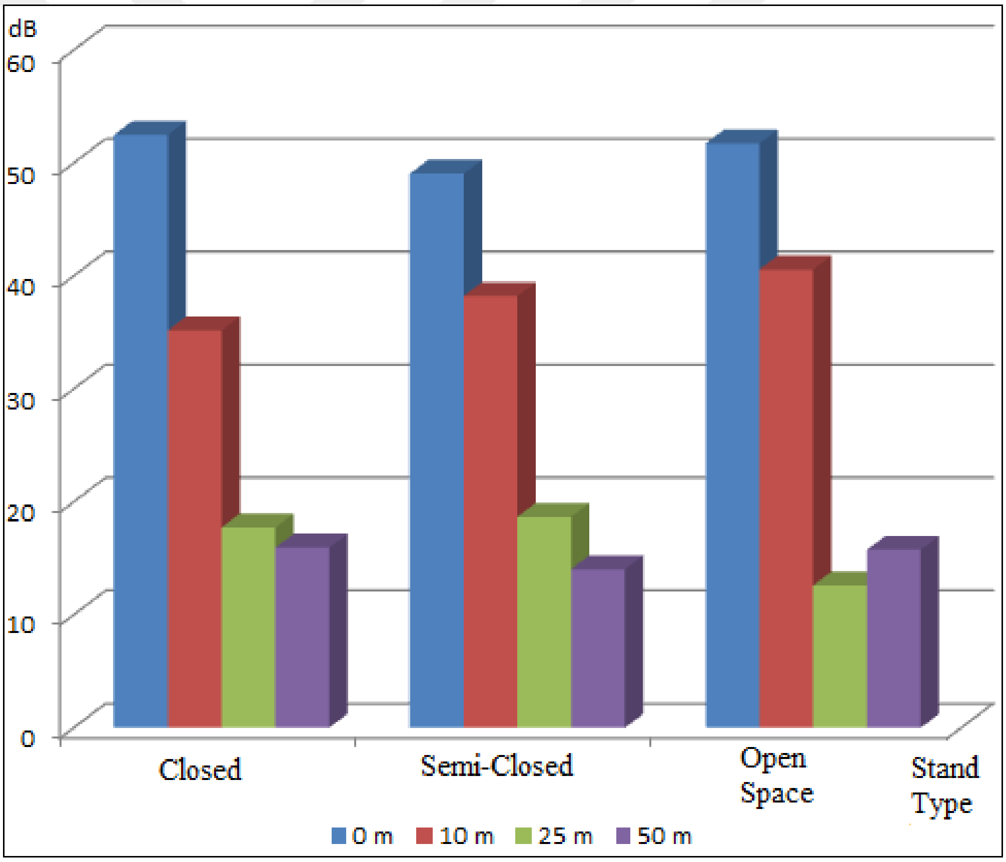

Figure 4.6. The graph showing the effect of stand closeness on the net sound values

The F value, eror rate, mean values and Duncan test result groupings obtained by the variance analysis that were the results of the measurements and calculations conducted in order to determine the variation of nt sounbd value depending on the stand development age are given on Table 4.12.

Table 4.12. *The effect of stand development age on net sound values*

Stand Type	**Distance (m)**			
	0	**10**	**25**	**50**
Mature Stand	52,225 b	40,586 b	19,450 b	21,171 c
Young Stand	49,324 a	32,811 a	16,975 b	8,830 a
Open Spaces	51,730 b	40,579 b	12,612 a	15,760 b
F Value	16,587	20,999	11,465	117,165
Eror	,000	,000	,000	,000

As a result of the variance analysis, it was determined that the net sound values differed significantly at 99.9% confidence level depending on the development age of the stands at all distances. At the end of the Duncan test, the data obtained at a distance of 50 m produced three homogeneous groups and each of development age of stands were in separate homogeneous groups. At other distances; at starting point and at 10 m distance young stands; at 25 m distance open spaces formed the first homogeneous group while the other stands were in the second homogeneous group. The graph representing the variation of net sound values depending on the development age of stands is given on Figure 4.7.

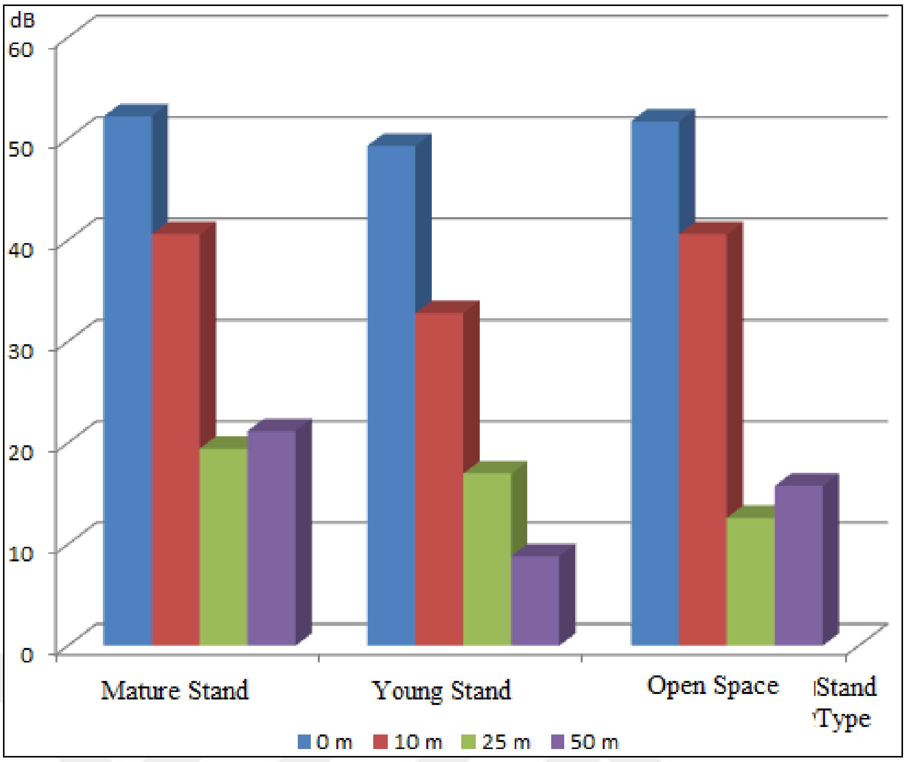

Figure 4.7. The effect of stand development age on net sound values

Within the scope of the study, each factor (stand type, closeness and development age) subject to the study was evaluated as a separate factor and the change in net sound level was calculated depending on these factors. The variance analysis was applied to the data obtained as a result of the calculations made and the F value, error rate, mean values and Duncan test result groupings obtained as a result of variance analysis are presented on the Table 4.13.

Table 4.13. *Net sound values*

Stand			**Distance (m)**			
Type	**Closeness**	**Development**	**0**	**10**	**25**	**50**
Leafy	**Semi-Closed**	**Young**	40,817 a	51,109 f	25,039 e	16,267 d
		Mature	52,248 c	42,912 de	23,155 e	18,370 e
	Closed	**Genç**	49,567 b	34,303 b	18,839 d	10,706 c
		Olgun	52,627 c	38,412 c	18,173 d	23,664 f
Coniferous	**Semi-Closed**	**Young**	51,200 c	23,023 a	14,707 c	7,180 b
		Mature	51,958 c	35,833 b	11,824 ab	14,385 d
	Closed	**Genç**	55,713 d	22,810 a	9,313 a	1,167 a
		Olgun	52,067 c	45,188 e	24,648 e	28,264 g

Table 4.13. continued

Open spaces	51,730 c	40,579 cd	12,612 bc	15,760 d
F value	80,755	107,785	35,563	141,037
Eror	,000	,000	,000	,000

As can be seen from the table, the net sound values calculated at 10, 25 and 50 m distances all varied at p < 0,01 significance level in terms of stand structure.

The correlation between the distance of the noise source and the net sound values was determined by performing an analysis of variance. The distances were assessed by the Duncan test. When the data is evaluated on the base of the distances, according to the Duncan test results, the lowest value at initial level was calculated in “semi-closed young leafy stands” as 40,817 dB, while the highest value was calculated in “closed young coniferous stands”. The lowest values at the distance of 10 m were calculated in “closed young coniferous stands” (22,810 dB) and “semi-closed young coniferous stands” (23,023 dB). And the highest values at the distance of 10 m were calculated in “ semi-closed young leafy stands” (51,109 dB).

While the lowest values at the distance of 25 m were calculated in “closed young coniferous stands” (9,313 dB) and “semi-closed mature coniferous stands” (11,824 dB); the highest values were of “semi-closed mature leafy stands” (23,155 dB), “closed mature coniferous stands” (24,648 dB), “semi-closed young leafy stands” (25,039 dB). As for 50 m distance; the lowest values were calsulatedin “ closed young coniferous stands” as 1,167 dB; while the highest values were of “closed mature coniferous stands” as 28,264 dB. The graph representing the variation of net sound values on the base of distances depending on stand structure is given on Figure 4.8.

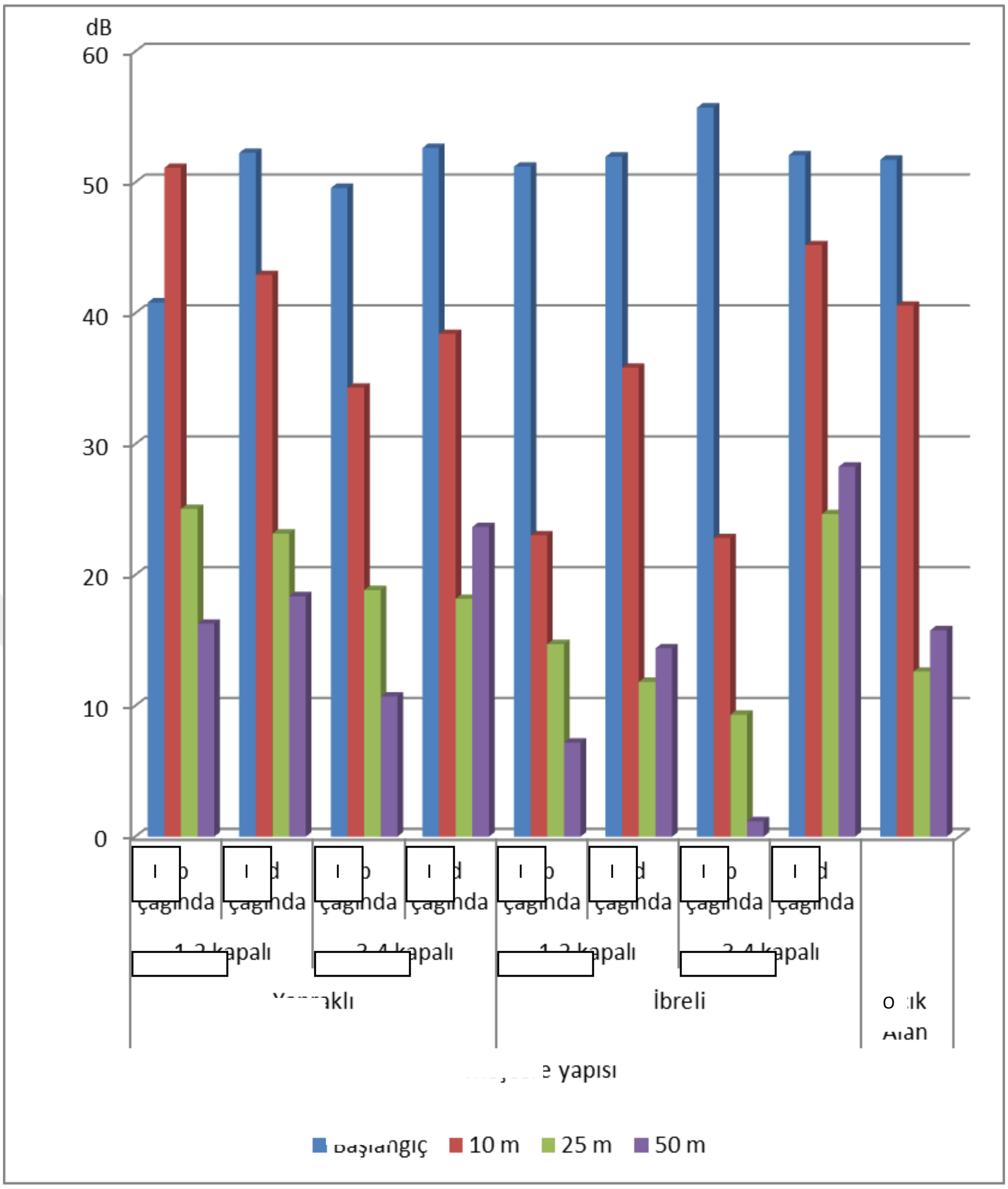

Figure 4.8. The variation of net sound values on the base of distances depending on stand structure

4.1.3. Correlation Between Stand Type- Value of Net Sound Proportions

Variance analysis was conducted to determine the effect of net sound ratio on stand type. The mean values of net sound ratio depending on stand type, F value calculated by variance analysis and error rate and Duncan test result groupings are given in the Table 4.14.

Table 4.14. *The effect of stand type on net sound amounts*

Stand Type	**Distance (m)**			
	0	**10**	**25**	**50**
Leafy	100	87,639 c	44,339 b	35,261 b
Coniferous	100	60,910 a	29,154 a	24,554 a
Open spaces	100	78,382 b	24,403 a	30,412 ab
F Value	-	42,520	42,714	12,280
Eror	-	,000	,000	,000

As shown in the Table, the net sound ratios differ statistically at all distances, depending on the type of stand, meaningful at 99.9% confidence level. This difference is significant at 99.9% confidence level at all distances.

As a result of the Duncan test, three homogeneous groups were formed at distance of 10 m, and two at 25m and 50 m.

When the mean values were examined, the maximum decrease according to the starting point was in the coniferous forests with a distance of 10 m and 50 m, and in the open spaces with a distance of 25 m. In the coniferous forests, the net volume of sound decreased to 60,910% of the initial level at 10 m, 29,154% at 25 m and 24,554% at 50 m. The graphical representation of the effect of the stand type on the net sound ratios is given on the Figure 4.9.

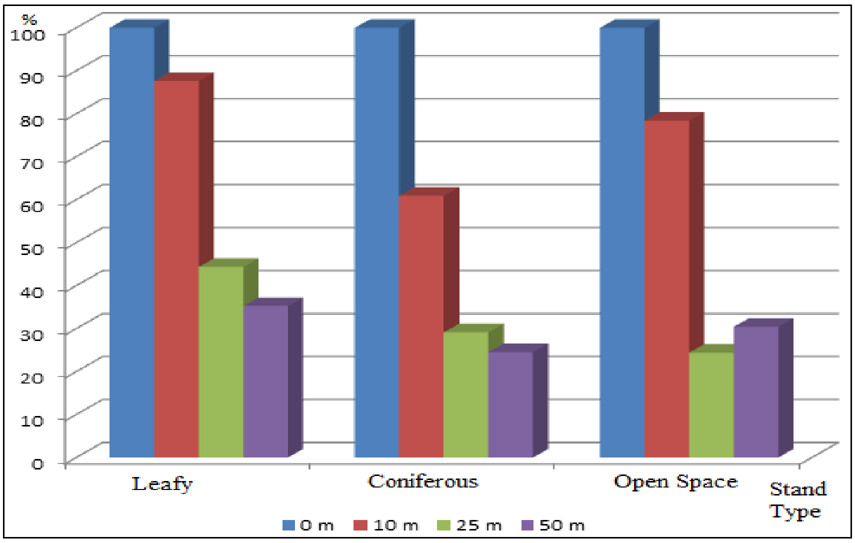

Figure 4.9. The effect of the stand type on the net sound ratios

The F value, error rate, mean values and Duncan test result groupings obtained as a result of the variance analysis applied to the data to determine the effect of stand closeness on net sound ratios are given in the Table 4.15.

Table 4.15. *The effect of stand closeness on net sound ratios*

Stand closeness	**Distance (m)**			
	0	**10**	**25**	**50**
Closed	100	67,459 a	34,131 b	30,748
Semi-closed	100	81,091 b	39,362 b	29,067
Open spaces	100	78,382 b	24,403 a	30,412
F Value		10,171	11,874	,461
Eror		,000	,000	,631

As a result of the analysis of variance, it was determined that the variation of net sound ratios due to the stand closeness was not statistically significant at at least 95% confidence level at 50 m, however it was statistically significant at 99.9% confidence level at 10 and 25 m distances. The lowest value at 10 m distance was obtained from the closed stands and the lowest value at 25 m distance was obtained from the open spaces. The graphical representation of the effect of stand closeness on net sound ratios is given in the Figure 4.10.

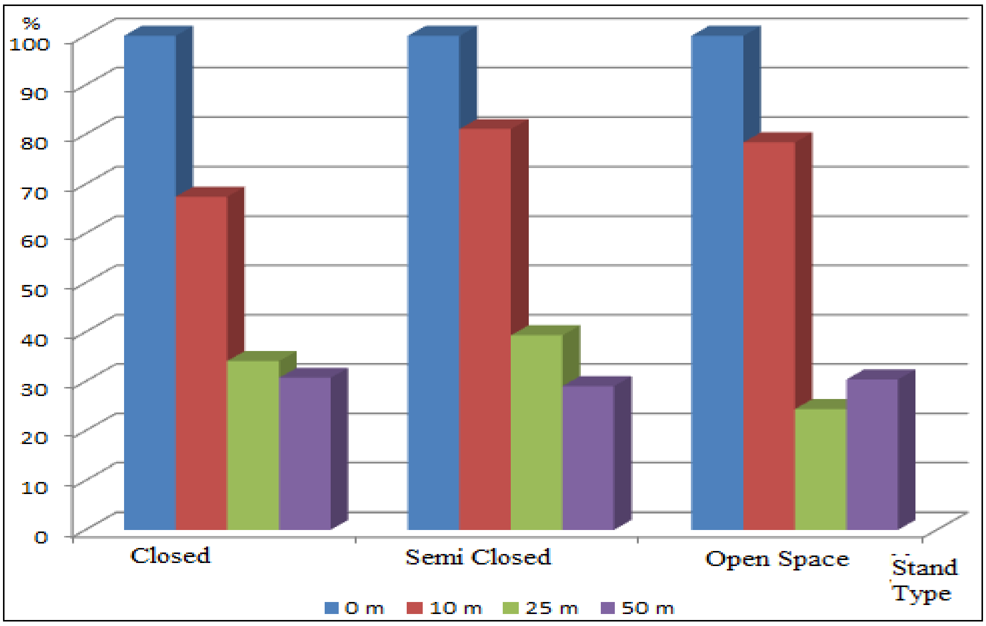

Figure 4.10. The effect of stand closeness on net sound ratios

The F value, error rate, mean values and Duncan test result groupings obtained as a result of the variance analysis and Duncan test that were applied to the data to determine the effect of stand development age, which was one of the factors to be evaluated within the scope of the study, on the net sound ratios.

Table 4.16. *The effect of stand development age on the net sound ratios*

Stand Development Age	**Distance (m)**			
	0	**10**	**25**	**50**
Mature stand	100	77,710	37,217 b	40,509 c
Young stand	100	70,839	36,276 b	19,306 a
Open spaces	100	78,382	24,403 a	30,412 b
F Value		1,791	8,620	74,466
Eror		,169	,000	,000

While the variation of net sound ratios depending on stand development age varied at (p < 0,01)significance level at the distances of 25m and 50 m, it was determined not to vary statistically (p < 0,05) at the distance of 10m. At the end of the Duncan test, there were two homogeneous groups at 25 m and three homogeneous groups at 50 m. The lowest value were obtained in open spaces at 25 m distance, and the lowest value at 50 m distance was obtained at young stands. The graph showing the effect of stand development age on the net sound ratios is given in Figure 4.11.

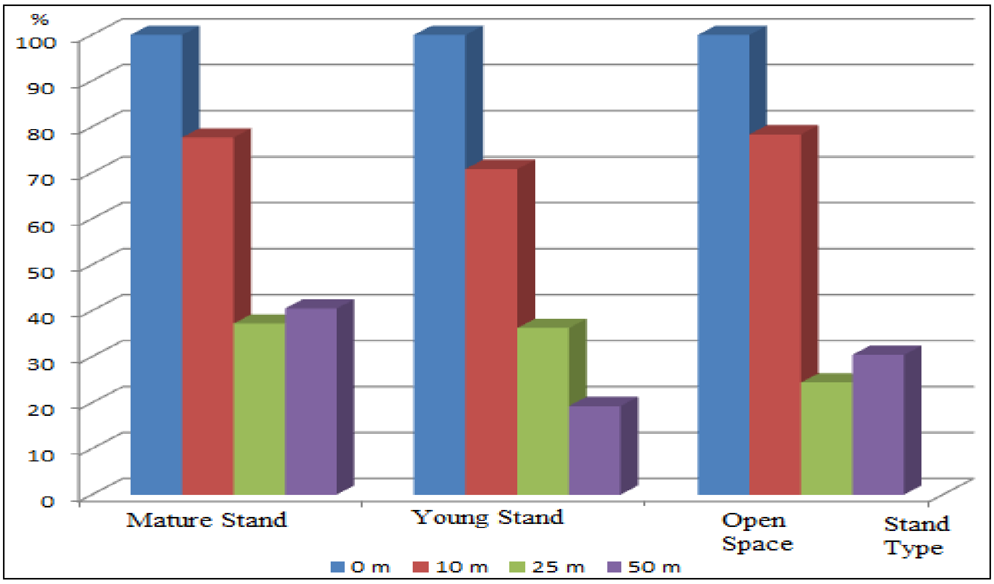

Figure 4.11. The effect of stand development age on the net sound ratios

One of the main purposes of this study was to determine the stand structure that reduces the amount of sound to the greatest extent. Therefore, in calculated net sound amount the initial level was accepted as 100 units (100%) and the ratio of other distance values to this number was calculated. Thus, it was aimed to determine the stand structure that reduces the net amount of sound to the highest level. The mean values of net sound ratio depending on stand structure, F value calculated by variance analysis and error rate and Duncan test result groupings are given in the Table 4.17.

Table 4.17. *Net sound ratios*

Stand			**Distance (m)**			
Type	**Closeness**	**Development**	**0**	**10**	**25**	**50**
Leafy	**Semi-Closed**	**Young**	100	126,27 g	60,573 f	39,294 f
		Mature	100	82,142 ef	44,315 e	35,158 e
	Closed	**Young**	100	69,197 c	37,973 d	21,618 c
		Mature	100	72,948 cd	34,494 cd	44,973 g
Coniferous	**Semi-Closed**	**Young**	100	47,023 b	29,857 c	14,177 b
		Mature	100	68,927 c	22,703 b	27,639 d
	Closed	**Young**	100	40,867 a	16,700 a	2,133 a
		Mature	100	86,824 f	47,355 e	54,267 h
		Open Spaces 1	100	78,382 de	24,403 b	30,412 d
		F Value		146,161	51,182	132,350
		Eror		,000	,000	,000

When the table values are examined, it is observed that the values measured at 10, 25 and 50 m distances varied statistically ($p < 0,01$). in terms of stand structure. Among the areas where the measurements were conducted, the sound ratio was only higher in “semi-covered young leafy stands” than the starting point at 10 m distance. Except this, the sound level decreases at all other points depending on the distance.

When distance of noise resource to the stand-based assessments were conducted, the lowest proportional value was determined at 10m distance in “closed young coniferous forests”. In this forest, the net sound ratio at 10 m has decreased to 40,867%. At 25 m and 50 m, the lowest values were also determined in “closed young coniferous forests”. In “closed young coniferous forests” the proportional net sound value was calculated as 16.7% at 25 m and 2.133% at 50 m. In the short distance (10 m), the second stand, which reduced the sound ratio the most, was “semi-closed young coniferous stands”. The same stand structure has been the second stand at 50 m, which again reduced the net sound ratio the most. The graph showing the variation of the proportional net sound values depending on the stand structure at distance base is given in the Figure 4.12.

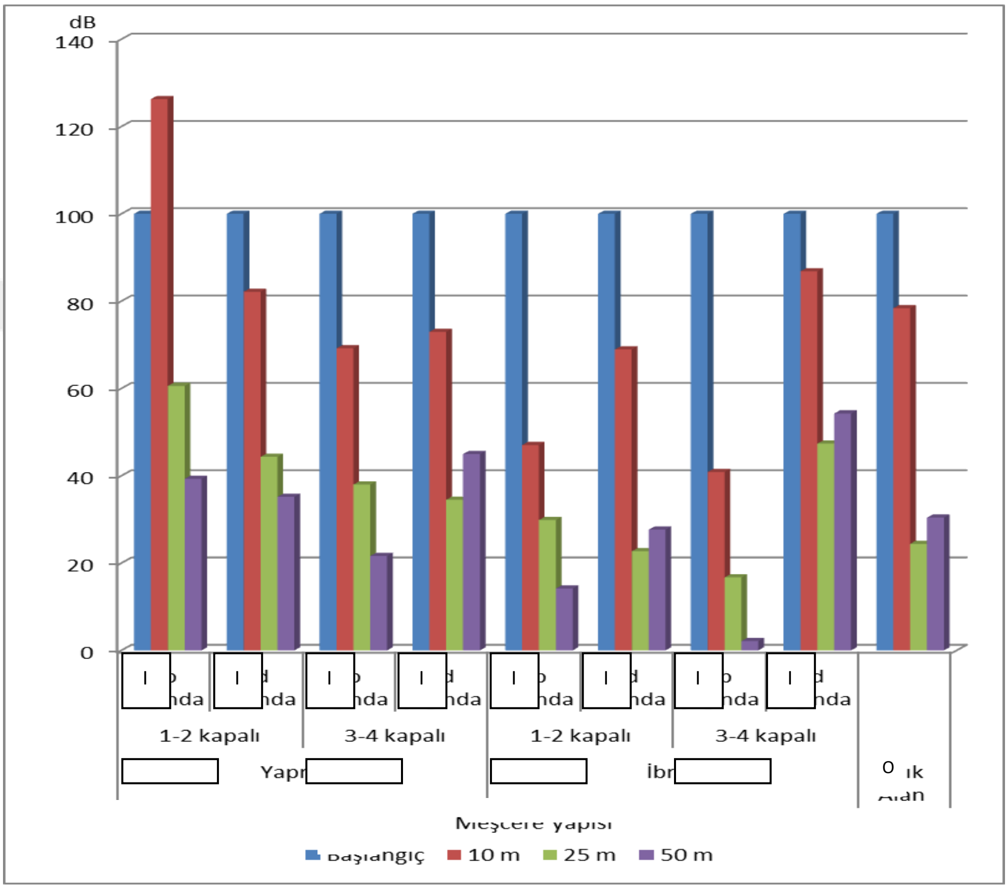

Figure 4.12. The variation of the proportional net sound values depending on the stand structure at distance base

The photograph taken during the measurement of sound in the land is given. (Photograph 4.1).

Photograph 4.1. A photograph taken during sound measurement on field

4.2. Measurement of Particulate Matter

According to the "Tests of Between-Subjects Effects^{a}" table ($P < 0.05$), there is a statistically significant difference between the variables of terrain, distance and particle size (Table 4.18. Tests of Between-Subjects Effects). Accordingly, it can be seen from Table 4.19, Table 4.20 and Table 4.21 which groups originated the differences. According to the "Tests of Between-Subjects Effectsa" table ($P < 0.05$), there is a statistically significant difference between the variables of land, distance and particle size (Table 4.7. Tests of Between-Subjects Effects). Accordingly, it can be seen from Table 4.19, Table 4.20 and Table 4.21 which groups originated the differences.

Table 4.18. *Tests of Between-Subjects Effects*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	153902877337,111^{a}	53	2903827874,285	1,757	,007
Intercept	437457271290,890	1	437457271290,890	264,739	,000
Stand	57707107693,778	8	7213388461,722	4,365	,000
Distance	6650863259,284	1	6650863259,284	4,025	,047
Partical Size	39392183101,148	2	19696091550,574	11,920	,000
Stand * distance	16041322184,049	8	2005165273,006	1,213	,298
Stand * Partical Size	21820057650,852	16	1363753603,178	,825	,655
distance * Partical Size	3374187752,457	2	1687093876,228	1,021	,364
Stand * distance * Partical Size	8917155695,543	16	557322230,971	,337	,992
Error	178460486132,000	108	1652411908,630		
Total	769820634760,000	162			
Corrected Total	332363363469,111	161			

Table 4.19. *Effect of the terrain on PM values*

Stand Type									
PM	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
PM Mean± SE	9296,17±13549,96^{a}	41237,72±13549,96^{ab}	63044,50±13549,96^{b}	53097,22±13549,96^{b}	65664,94±13549,96^{b}	56113,06±13549,96^{b}	43190,94±13549,96^{ab}	54813,61±13549,96^{b}	81226,17±13549,96^{b}
^{a,b,c,d} **symbols indicate the state of difference.**									

Table 4.20. *Effect of distance on PM values*

	Distance	
PM	**1**	**2**
Mean±SE	45557,53±4516,65	58372,32±4516,65

Table 4.21. *Effect of particulate size on PM values*

	Partical Size		
PM	**1**	**2**	**3**
Mean±SE	32199,83±7823,07^{b}	53377,04±7823,07^{b}	70317,91±7823,07^{a}
^{a,b} **symbols indicate the state of difference.**			

As shown in Table 4.18, in the PM measurement, the state of the forest cover Sig. (p = 0.00) was found to be significant. In other words, the impact of the forest cover situation on PM was found to be significant. The effect of distance was also found to be significant (p = 0.047) on PM. Again, the particle size was found to be effective on PM (p = 0.00) at the results of the analysis.

When the Tukey multiple comparison test results in Table 4.19 were examined, the amount of PM was highest in the terrain with “closed young coniferous stands”, while the values of the terrains with “semi-closed mature leafy stands”, “ closed mature coniferous stands”, “semi-closed mature coniferous stands”, “ closed young leafy stands” and “semi-closed mature coniferous stands” have similarity between each other. The amount of PM in open spaces shows the lowest average level, showing similarity with the terrains of “semi-closed young leafy stands” and“closed mature leafy stands”.

Evaluating Tukey multiple comparison test results in Table 4.20, it was revealed that there is a significant correlation between distance and PM amount in different areas according to Tukey multiple comparison test results. Accordingly, it has been revealed that the range of distance of the highest average value of amount of particles is 0-20 m.

Table 4.21 shows that there is a corelation between particle size and PM. The mean level of the amount of particles in the size of 5 µm was found to be the highest. The particle sizes of 0.3 µm and 0.5 µm are similar to each other and are lower than the PM size of 5 m.

4.2.1. Correlation Between Stand Type and Particulate Matter Amount

The results of the variance analysis and the mean values for the variation of the particulate matter amount depending on the type of stand are given in the Table 4.22.

Table 4.22. *The effect of stand type on dust amount*

Distance (m)		**PM1**	**PM2**	**PM3**
10 m	Opean space	76,267	87,37 b	27,67 b
	Coniferous	56,208	60,53 a	11,18 a
	Leafy	60,167	42,14 a	8,75 a
	F Value	1,737	6,812	10,218
	Eror	,197	,005	,001
20 m	Opean space	87,967 b	82,100 b	19,100
	Coniferous	39,925 a	39,617 a	9,675
	Leafy	53,583 a	42,775 a	7,417
	F Value	10,698	3,810	1,269
	Eror	,000	,037	,299

When the results of the table are examined, it can be seen that 76.267% of PM1 size dust in open spaces can reach at 10 m distance, while 56.28% of PM1 size dust in coniferous stands and 60.1167% of PM1 size dust in leafy stands can reach at 10 m distance. However, according to the results of variance analysis, there is no statistically significant difference between these values at (p > 0,05) significance level.

When the results of measurements made at 20 m distance were examined, it was found that 87.967% of dusts in the size of PM1 can reach 20 m distance in open spaces, whereas 53,583% of the dusts in leafy stands, and only 39,925% of dusts in

PM1 size can reach 20 m distance in coniferous stands. The graph in the Figure indicates the effect of stand type on PM1 size dust amount.

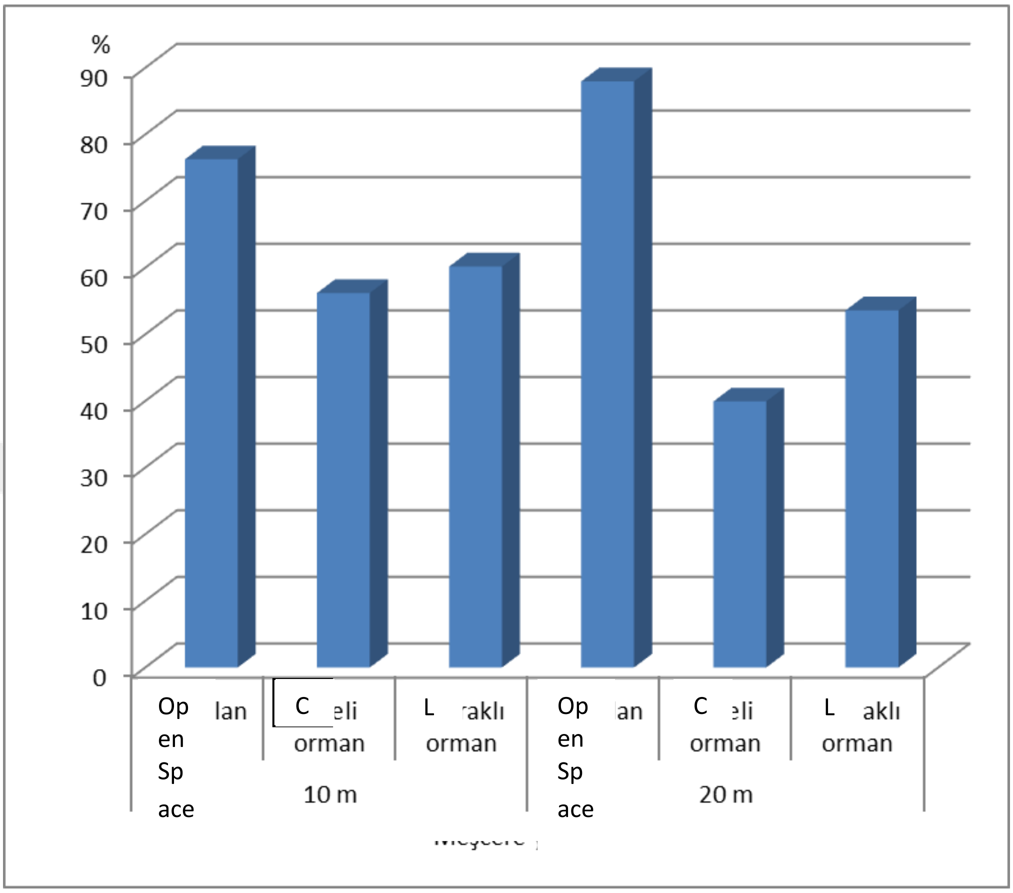

Figure 4.13. The effect of stand type on PM1 size dust amount

According to the table, when the variation of PM2 size dust amount depending on the distance is examined, it is seen that the change of the dust amount in terms of the stand types at both 10 m and 20 m distances is statistically significant at least at 95% confidence level. There is a significant difference between the values obtained at 10 m distance at 99% confidence level, and at 95% confidence level at 20 m distance.

When the mean values are examined, it is seen that 87.37% of the PM2 size dust reaches at 10 m distance in open spaces, while this ratio decreases to 60.53% in coniferous stands and to 42.14% in the leafy stands. According to the table values, 82.1% of the dusts of the PM2 size in the open spaces reach 20 m distance, whereas only 39,617% of the dusts of the PM2 size in coniferous stands and only 42,775% of the PM2 size dusts in the leafy stands reach 20 m distance. The graph indicating the effect of stand type on PM2 size dust amount is given in the Figure 4.14.

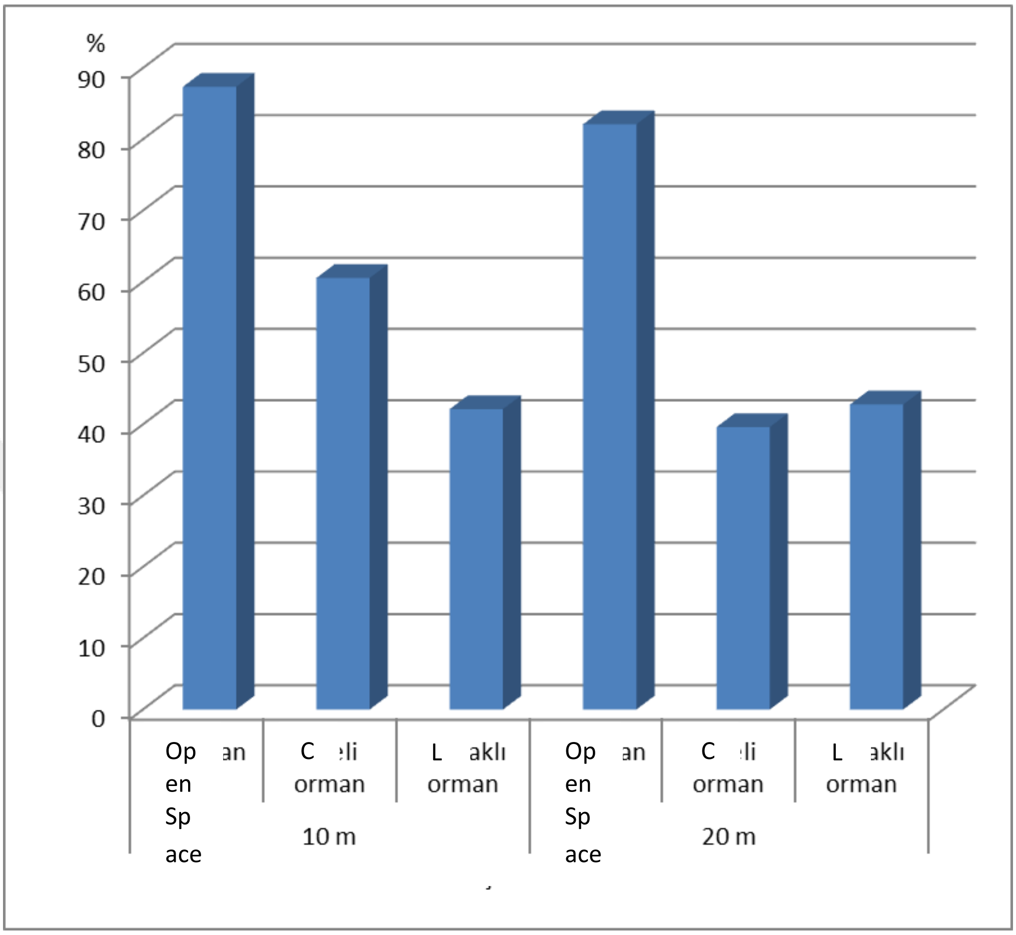

Figure 4.14. The effect of stand type on PM2 size dust amount

When the influence of the stand type on the PM3 size dust is examined, it can be seen that while 27.67% of PM3 size dust can reach 10 m distance in open spaces, only 11,18% of the dusts in this size in coniferous stands and only 8,75% in leafy stands can reach 10 m distance. Similarly, it was determined that only 9,675% of the dust in this size can reach 20 m distance in coniferous stands, and only 7,417% of the dust can reach to 20 m distance in leafy stands, whereas 19,1% of PM3 size dusts can reach 20 m distance in open spaces. The graph indicating the effect of stand type on PM3 size dust amount is given in the Figure 4.15.

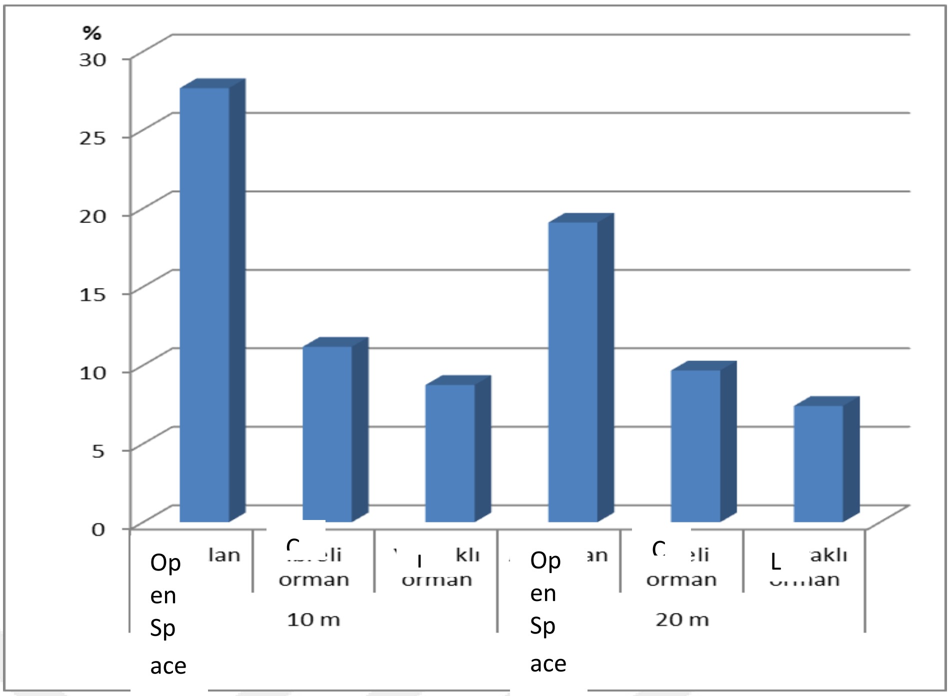

Figure 4.15. The effect of stand type on PM3 size dust amount

As a result of the study, the variance analysis was applied to determine the effect of stand closeness on the amount of dust, and the F value, error rate, the mean values obtained as a result of the variance analysis and the homogeneous groups resulting from the Duncan test are given in the Table 4.23.

Table 4.23. *The effect of stand closeness on dust amount*

Distance		**PM1**	**PM2**	**PM3**
10 m	Open Spaces	76,267 b	87,37 b	27,67 b
	Semi-closed	67,308 b	57,60 a	10,60 a
	closed	49,067 a	45,07 a	9,33 a
	F Value	7,219	4,914	9,677
	Eror	,004	,016	,001
20 m	Open Spaces	87,967 b	82,100 b	19,100
	Semi-closed	48,875 a	40,925 a	7,650
	closed	44,633 a	41,467 a	9,442
	F Value	7,574	3,745	1,221
	Eror	,003	,038	,313

When the results of the table are examined, it is seen that the effect of the closeness of the stands on all values other than 20 m distance values of PM3 size dust is statistically significant at least at 95% confidence level. This effect is significant at 95% confidence level on PM2 size dust and 99% confidence level on other values.

Examining the results of the table, it can be seen that while 76,267% of the PM1 size dusts in open spaces can reach 10 m, 67,308% of PM1 size dusts in semi-closed stands and 49,067% in closed stands can reach 10 m distance. It has been determined that 87,967% of the PM1 size dust can reach 20 m in open spaces while 48,875% of semi- closed stands and only 44,633% of the PM1 size dust in closed stands reach 20 m distance. The graph indicating the effect of stand closeness on PM1 size dust amount is given in the Figure 4.16.

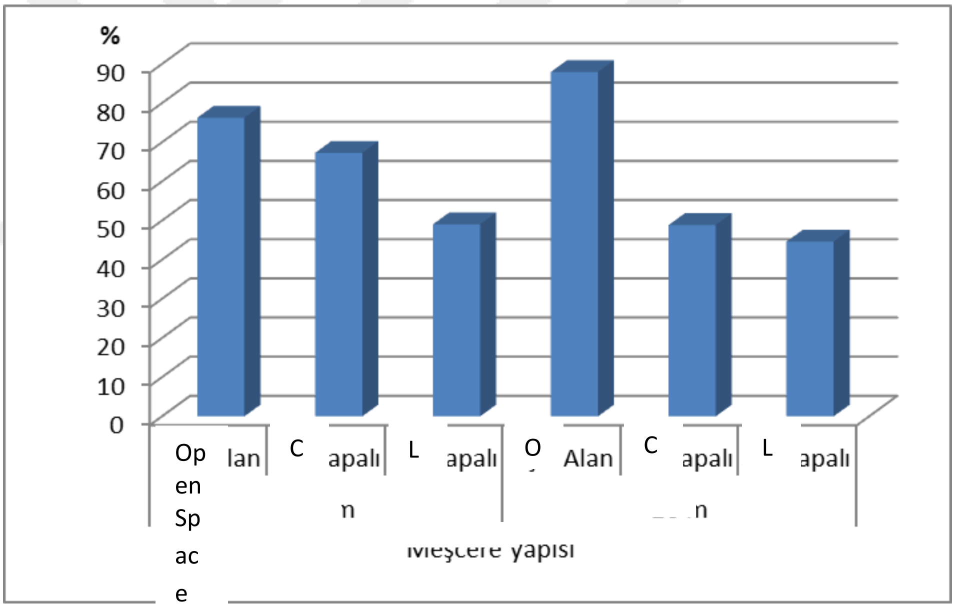

Figure 4.16. The effect of stand closeness on PM1 size dust amount

When the effect of stand closeness on PM2 size dust amount is examined, it can be seen that 87.37% of PM2 size dust can reach to 10 m distance in open spaces. However, this rate was calculated as 57,60% in semi-closed stands and as 45,07% in closed stands.

According to the measurement results, 82.1% of PM2 size dust in open spaces reach 20 m distance, but only 40,925% of PM2 size dust in semi-closed stands reaches to

20 m distance, and this ratiois only 41,467% in closed stands. The graph indicating the effect of stand closeness on PM2 size dust amount is given in the Figure 4.17.

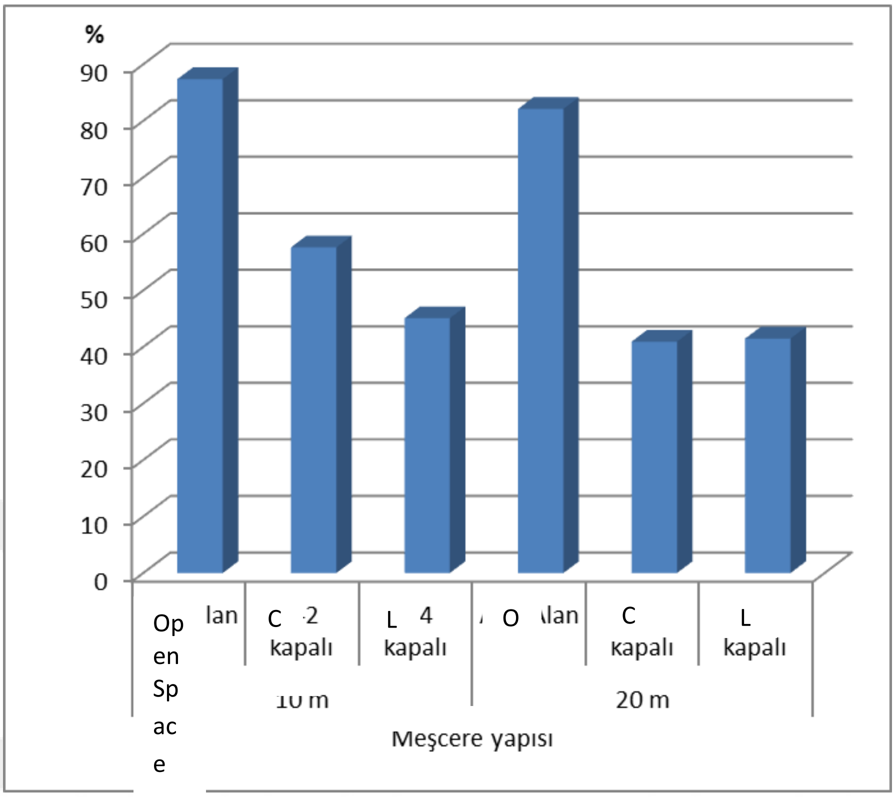

Figure 4.17. The effect of stand closeness on PM2 size dust amount

When the effect of the stand closeness on PM3 size dust amount is examined, 27.67% of PM3 size dust can reach 10 m distance in open spaces while only 10.60% of dust in this size in semi- closed forests and only 9.33% of PM3 size dust can reach at distance of 10 m. Similarly, it was determined that in the open spaces 19.1% of the PM3 size dust could reach 20 m, whereas only 7,650% of the dust in this size in semi-closed stands and 9,442% of PM3 size dust could reach at 20 m distance in closed stands. The graph indicating the effect of stand closeness on PM3 size dust amount is given in the Figure 4.18.

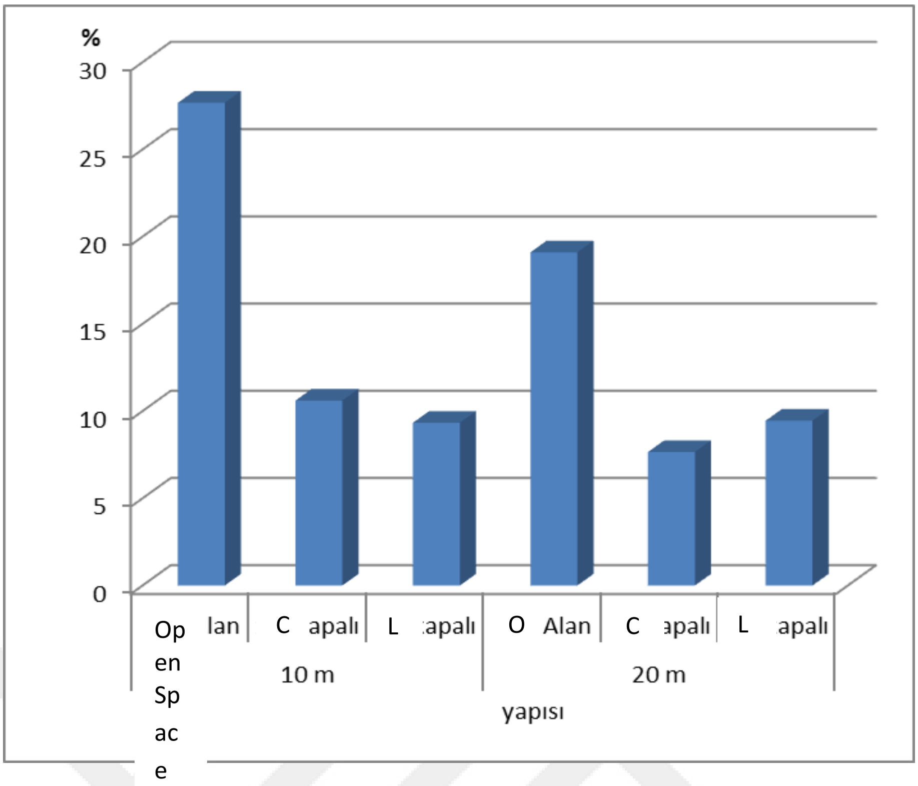

Figure 4.16. The effect of stand closeness on PM3 size dust amount

The variance analysis was applied to determine the effect of stand development age on the amount of dust, and the F value, error rate, the mean values obtained as a result of the variance analysis and the homogeneous groups resulting from the Duncan test are given in the Table 4.24.

Table 4.24. *The effect of stand development age on dust amount*

Distance		**PM1**	**PM2**	**PM3**
10 m	Open Spaces	76,267	87,37 b	27,67 b
	Young	57,625	51,52 a	8,60 a
	Mature	58,750	51,15 a	11,33 a
	F Value	1,562	3,553	10,421
	Eror	,230	,045	,001
20 m	Open Spaces	87,967 b	82,100 b	19,100
	Young	52,483 a	47,808 a	9,717
	Mature	41,025 a	34,583 a	7,375
	F Value	9,570	4,990	1,279
	Eror	,001	,015	,297

When the results of the table showing the effect of stand development age on dust amount are examined, it can be seen that 76,267% of the PM1 dusts in open spaces can reach at 10 m distance, 57,625% of PM1 dusts in young forests and 58,750% in mature forests can reach 10 m distance. However, according to the results of variance analysis, there is no statistically significant difference between these values at least at 95% confidence level.

When the results of measurements carried out at 20 m distance were analyzed, it was revealed that there are statistically significant differences between the values at 99% confidence level, and that 87,967% of PM1 dusts in open spaces can reach at 20 m distance, whereas 52,483% of PM1 dusts in young stands and only 41,025% of PM1 dusts can reach at 20 m distance in mature stands. The graph indicating the effect of stand development age on PM1 size dust amount is given in the Figure 4.19.

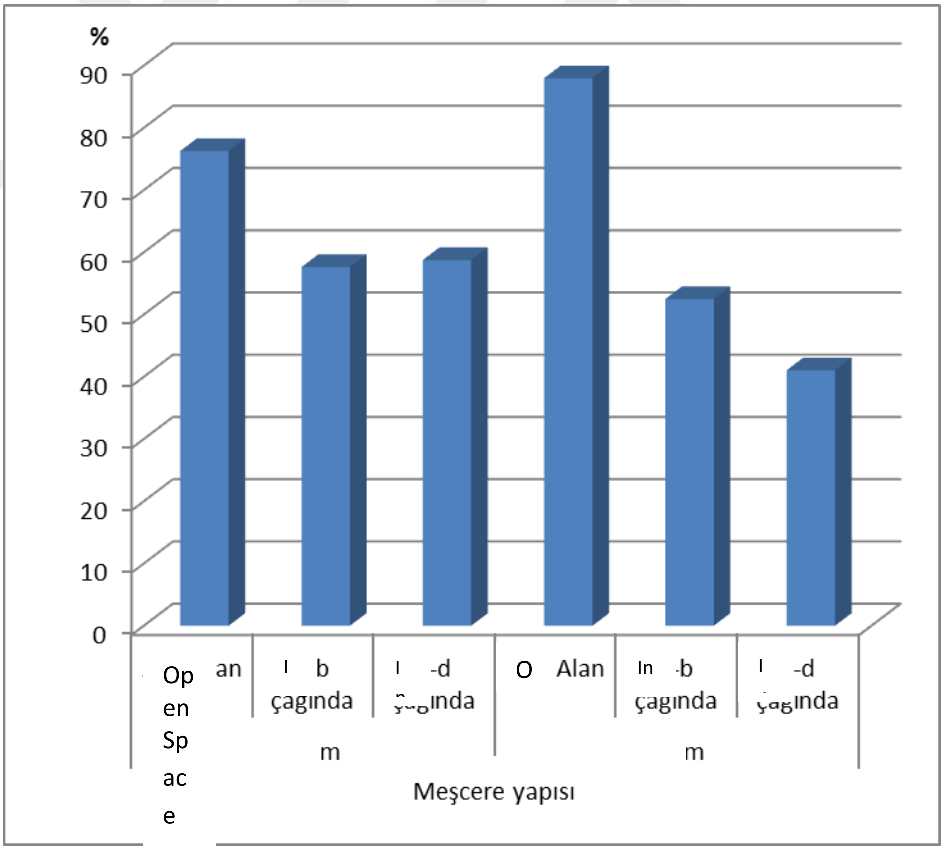

Figure 4.19. The effect of stand development age on PM1 size dust amount

According to the results of the table, when the variation of PM2 size dust depending on the distance is examined, it is seen that the change of dust amount in terms of stand type at both 10 m distance and 20 m distance is statistically significant at 95% confidence level. When the mean values are examined, 87.37% of PM2 size dust reaches at 10 m distance, while this ratio decreases to 51.52% in young forests and to 51.15% in the forests of c-d developmental age.

According to the table values, 82.1% of PM2 size dust in open spaces reach at 20 m distance, whereas 47,808% of PM2 size dust in young stands and 34,583% of PM2 size dust in mature stands can reach at 20 m. The graph indicating the effect of stand development age on PM2 size dust amount is given in the Figure 4.20.

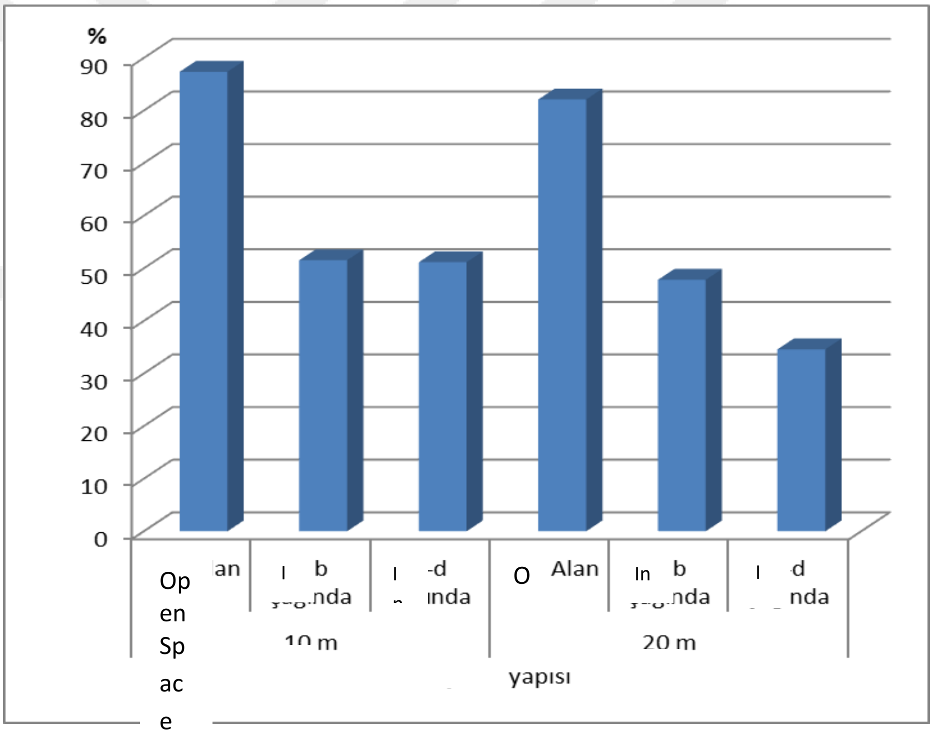

Figure 4.20. The effect of stand development age on PM2 size dust amount

Examining the effect of stand development age on PM3 size dust amount, it was determined that while 27.67% of the PM3 size dust in open spaces can reach at 10 m distance, only 8.6% of the dusts in this size in young stands, and 11.33% of the dusts in this size in mature stands can reach at a distance of 10 m. It was estimated that 19.1% of the PM3 size dust can reach at 20 m distance in open spaces, only 9,717% of the dust in this size can reach at 20 m distance in young forest and this ratio was only 7.375% in mature forests. The graph indicating the effect of stand development age on PM3 size dust amount is given in the Figure 4.21.

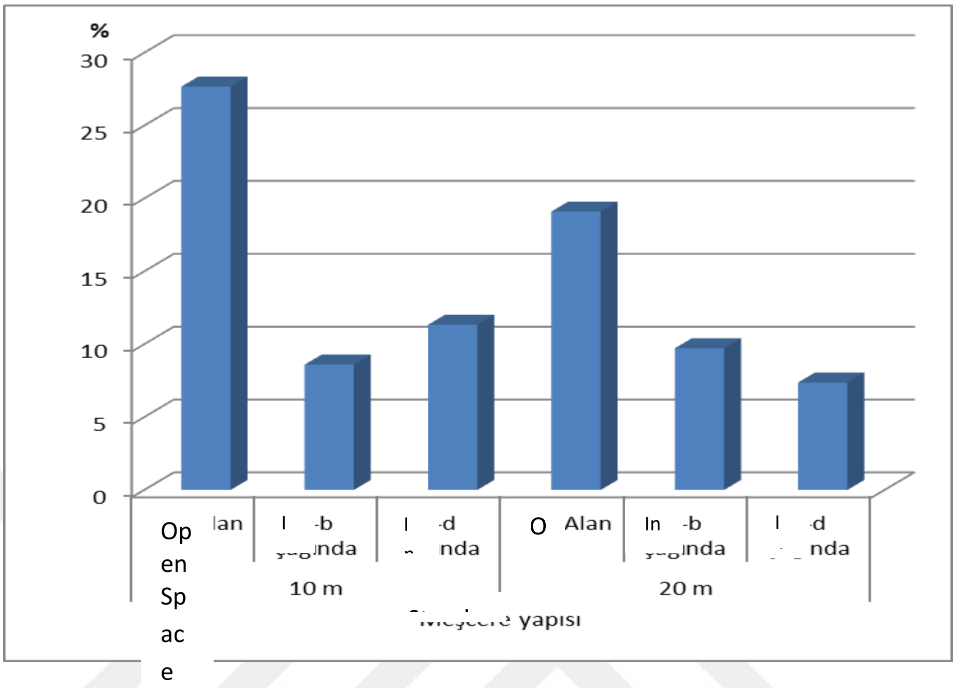

Figure 4.21. The effect of stand development age on PM3 size dust amount

It has been determined via measurements and calculations within the scope of the study that type, closeness and development age of stands are effective factors on the amount of dust. However, one of the main purposes of this study was to determine the most suitable stand to use in order to reduce the amount of dust, namely, to determine the structure of the stands that reduce the amount of dust to the greatest extent. Variance analysis was performed to determine the effect of the type, closeness and development age of stands on the amount of dust at 10 m distance within this purpose and the F value, error rate and the mean values obtained as a result of the variance analysis and the homogeneous groups formed as a result of the Duncan test are given in the Table 4.25.

Table 4.25. *The effect of stand type on the amount of dust at 10 m distance*

Stand			**Dust Size**		
Type	**Closeness**	**Development**	**PM1**	**PM2**	**PM3**
Leafy	Semi-closed	Young	82,433 c	70,33 d	6,37 a
		Mature	63,500 abc	35,00 ab	6,77 a
	Closed	Young	41,633 a	35,30 ab	10,00 a
		Mature	53,100 ab	27,93 a	11,87 a
Coniferous	Semi-closed	Young	62,433 abc	59,97 bcd	14,13 a
		Mature	60,867 abc	65,10 cd	15,13 a
	Closed	Young	44,000 a	40,47 abc	3,90 a
		Mature	57,533 abc	76,57 d	11,53 a
		Open Spaces			27,67 b
		F Value			3,605
		Eror			,011

When the results of the table are examined, it was determined that the structure of the stands is statistically effective at least at 95% confidence level on the amount of dust in all sizes at 10 m distance. This effect is significant at 95% confidence level for PM1 and PM3 size dusts and 99% confidence level for PM2 size dusts.

When the data on the variation of PM1 size dust is examined, it can be seen that 76,267% of PM1 size dust can reach at 10 m distance in open space. This rate was calculated as 82,433% only in young semi-closed leafy forests. The values calculated for all the other stands are lower than the value calculated in open space. The lowest transfer rates of the dusts at 10 m distance were calculated in “closed young leafy stands” (%41,633) and “closed young coniferous stands” (%44). The graph indicating the effect of stand structure on PM1 size dust amount at 10 m distance is given in the Figure 4.22.

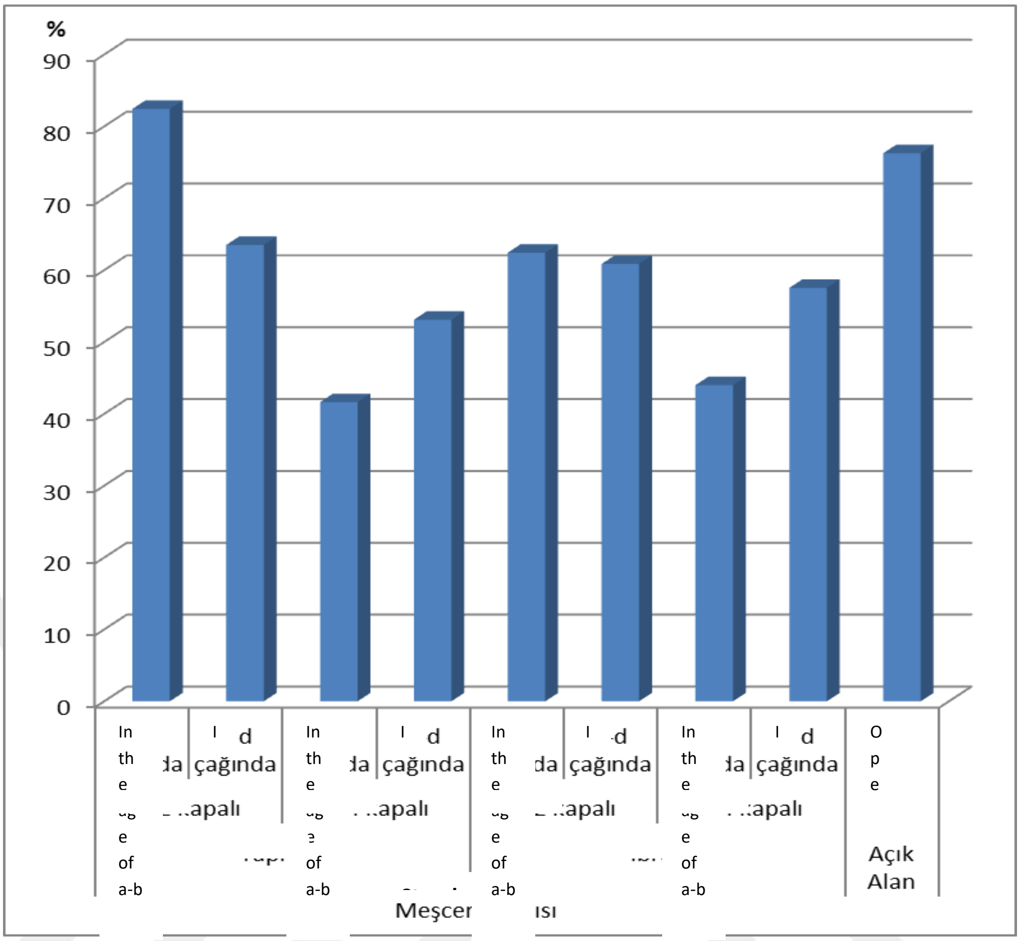

Figure 4.22. The effect of stand structure on PM1 size dust amount at 10 m distance

When the effect of stand structure on PM2 size dust is examined, it is seen that the highest value is obtained in open spaces. It was determined that 87.37% of dusts in the size of PM2 in open spaces could reach at 10 m distance. This rate was lower in all other stands. However, it has been determined that the most effective stands on PM2 size dust are “closed mature leafy stands”, and only 27.93% of dusts in the size of PM2 in these forests can reach at 10 m. The lowest values after this were obtained in “semi- closed mature leafy stands” (35%) and “closed young leafy stands” (35.30%). It is noteworthy that the lowest values were obtained in leafy forests. The graph shows the effect of the stand structure on the amount of PM 2 size dust at 10 m distance is given in Figure 4.23.

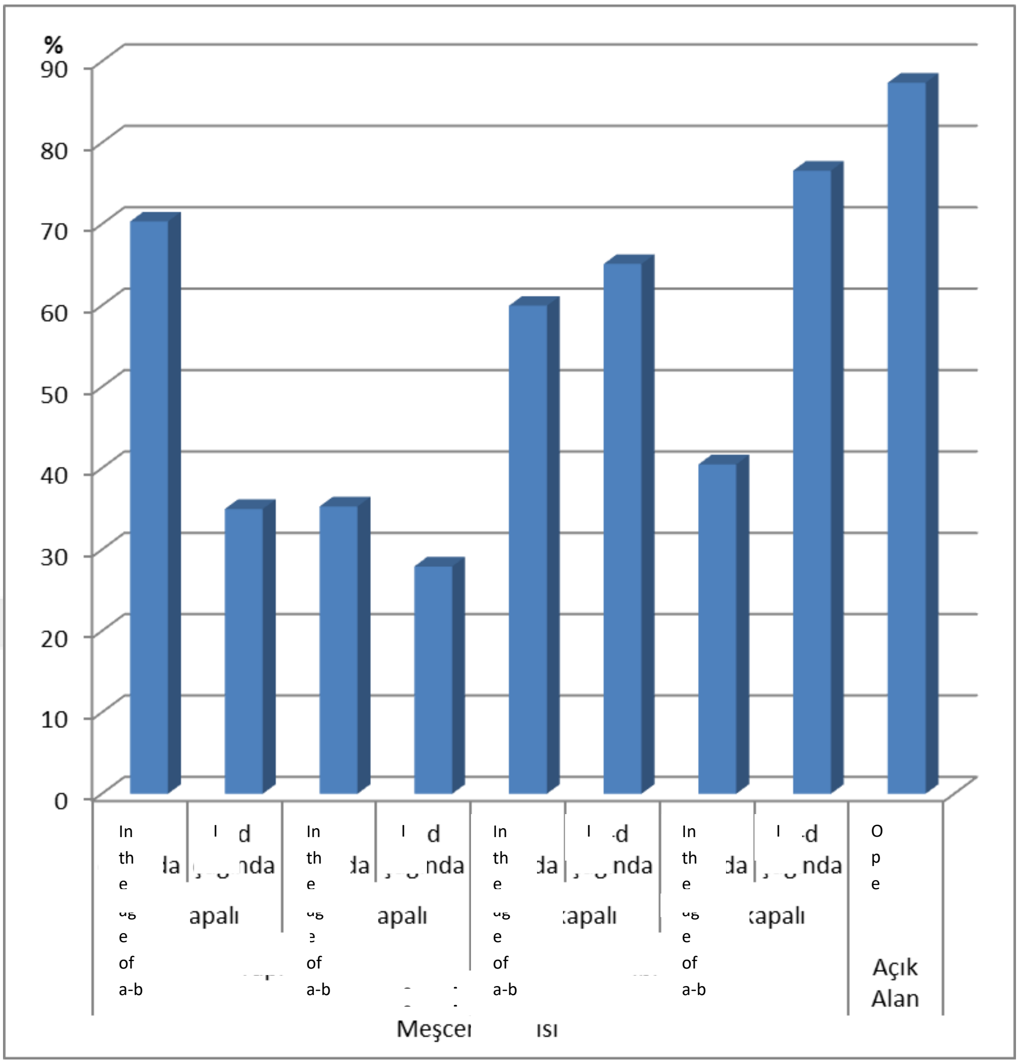

Figure 4.23. The effect of the stand structure on the amount of PM 2 size dust at 10 m distance

When the effect of the stand structure on PM3, which is the largest size dust, is examined, it is seen that all data are collected in only two homogenous groups and while the open spaces are in one homogeneous group, the other stands are collected in the other homogeneous group. 27.67% of the PM3 size dust in the open spaces reach at 10 m distance, while this ratio varies between 3.90% and 15.13% in the forest areas. However, there is no statistically significant difference at least at 95% confidence level between these values. Therefore, it can stated according to this data that all of the stand structures subjected to this study are effective on PM3 sized dusts. However, it can be said that the most effective stands are “closed young coniferous stands” and “semi-closed leafy stands”. The graph shows the effect of stand structure on the PM3 size dust at amount at 10 m distance is given in Figure 4.24.

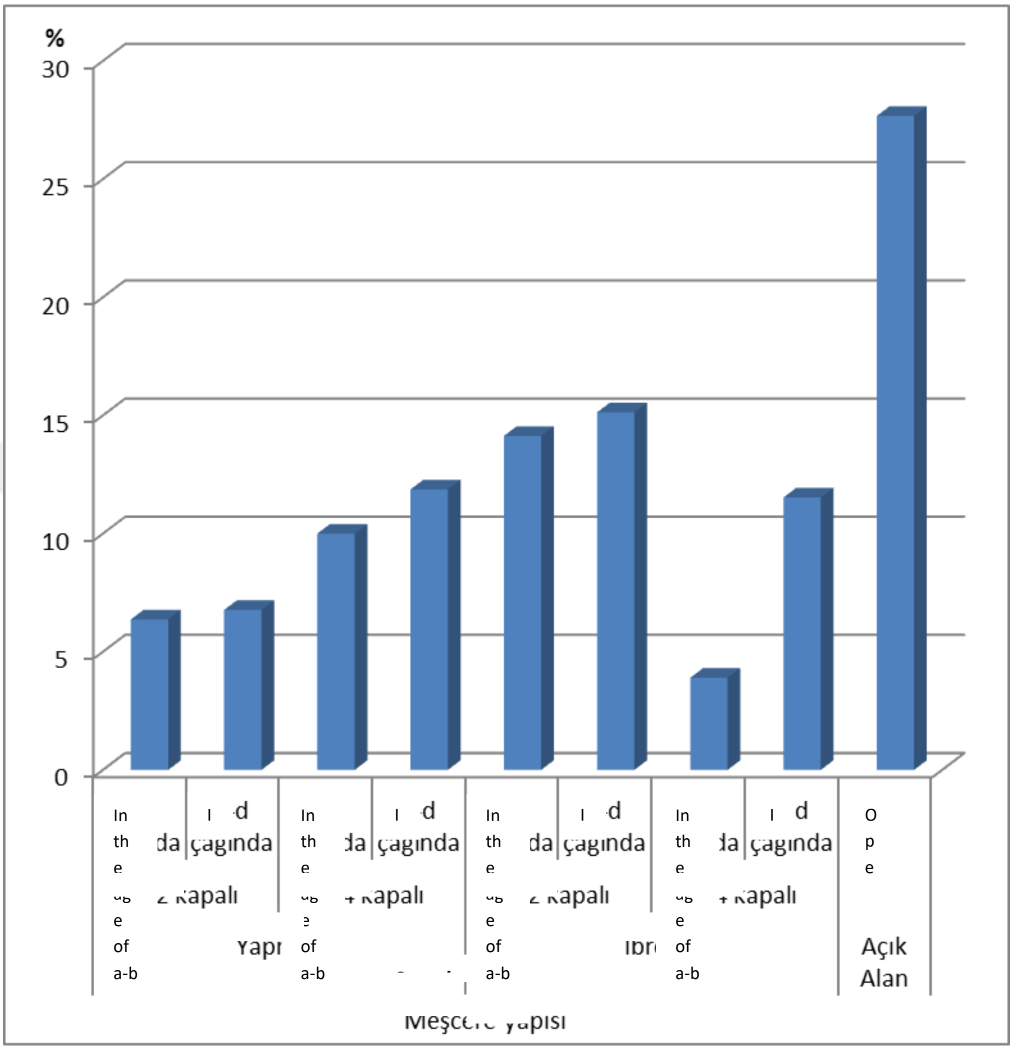

Figure 4.24. The effect of stand structure on the PM3 size dust at amount at 10 m distance

In the study, the F value, error rate and mean values obtained as a result of variance analysis applied to the data to determine the effect of the type of stand, closeness and development age on the amount of dust at 20 m distance, and homogeneous groups formed as a result of Duncan test are given in the Table 4.26.

Table 4.26. *The effect of stand structure on the amount of dust at 20 m distance*

Stand			**Dust Size**		
Type	**Closeness**	**Development**	**PM1**	**PM2**	**PM3**
Leafy	Semi-closed	Young	75,600 b	70,767 bc	7,700
		Mature	46,967 a	24,200 a	10,500
	Closed	Young	45,500 a	26,267 a	1,533
		Mature	46,267 a	49,867 abc	9,933
Coniferous	Semi-closed	Young	40,533 a	38,733 ab	6,100
		Mature	32,400 a	30,000 ab	6,300
	Closed	Young	48,300 a	55,467 abc	23,533
		Mature	38,467 a	34,267 ab	2,767
Open Spaces					19,100
F Value					1,328
Hata					,292

According to the results of the table, it was determined that the structure of the stands is statistically effective at the 95% confidence level on the amount of PM1 and PM2 dust at 20 m distance. This effect is significant at 99% confidence level for PM1 size dust and 95% confidence level for PM2 size. When the data on the variation of PM1 size dust is examined, it can be seen that 87,967% of PM1 size dust can reach at 20 m distance. The values calculated for all the stands are lower than the calculated value for open spaces. The transport rates of the dusts at 20 m distance were calculated in “semi- closed young leafy stands” other than open spaces with the highest rate of 75.6%. This forest and open spaces were in the same homogeneous group as a result of the Duncan test, while all other stands constituted the other homogeneous group. The lowest values were calculated in “semi-closed mature coniferous stands” (32.4%) and “closed mature coniferous stands” (38.467%). The graph shows the effect of stand structure on the amount of PM1 size dust at 20 m distance is given in Figure 4.25.

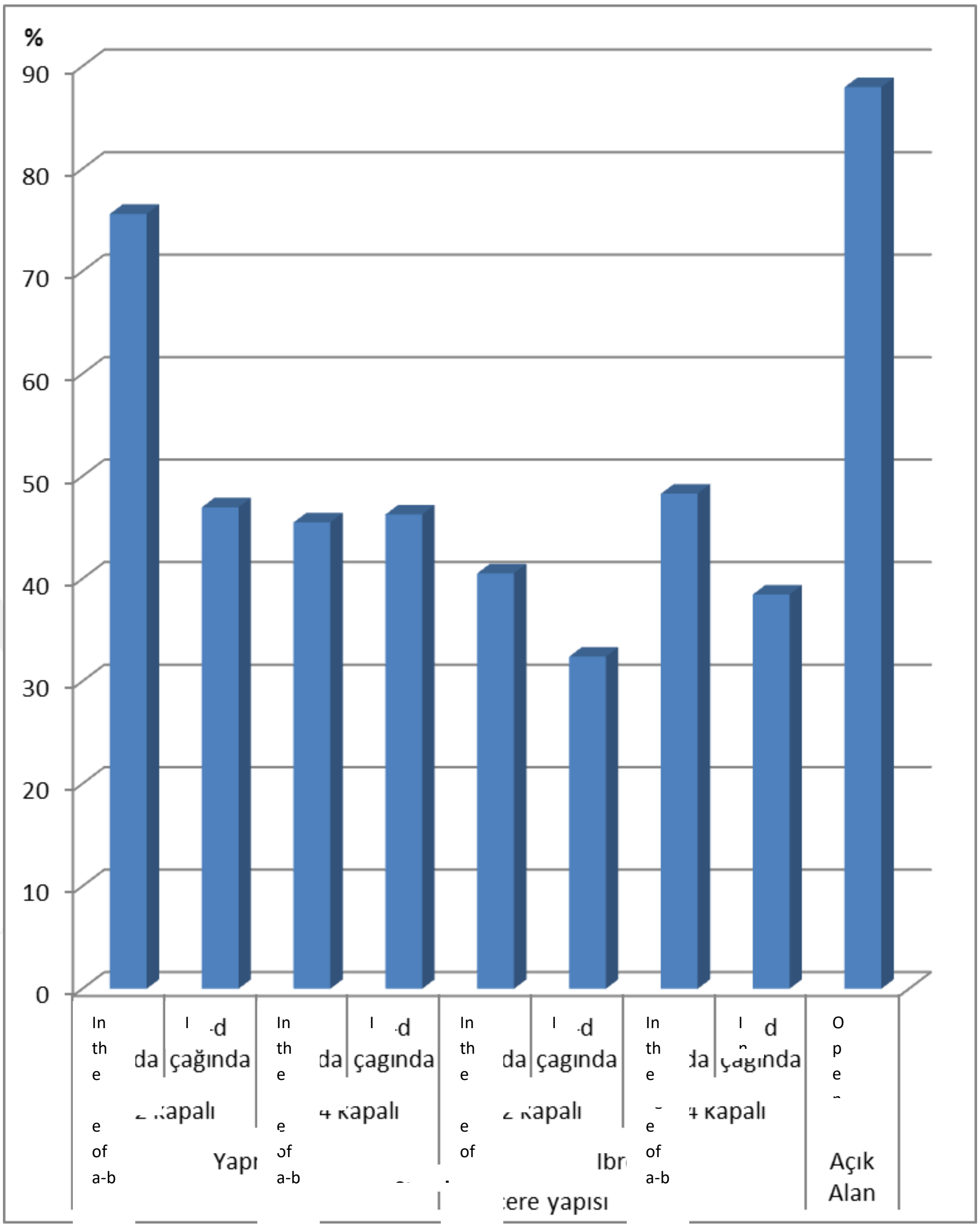

Figure 4.25. The effect of stand structure on the amount of PM1 size dust at 20 m distance

When the effect of stand structure on the PM2 size dust amount is examined, it is seen that the highest values were obtained in open spaces. It has been determined that 82.1% of the PM2 size dust can reach at 20 m distance in open space. As a result of the Duncan test, three homogenous groups were formed and the open area was only in the third homogeneous group. It was determined that the most effective stands on dusts of PM2 size were “semi- closed mature leafy stands” (24.2%) and “closed young leafy stands” (26.267%). It is noteworthy that the lowest values were obtained in leafy forests. The graph shows the effect of stand structure on the amount of PM2 size dust at 20 m distance is given in Figure 4.26.

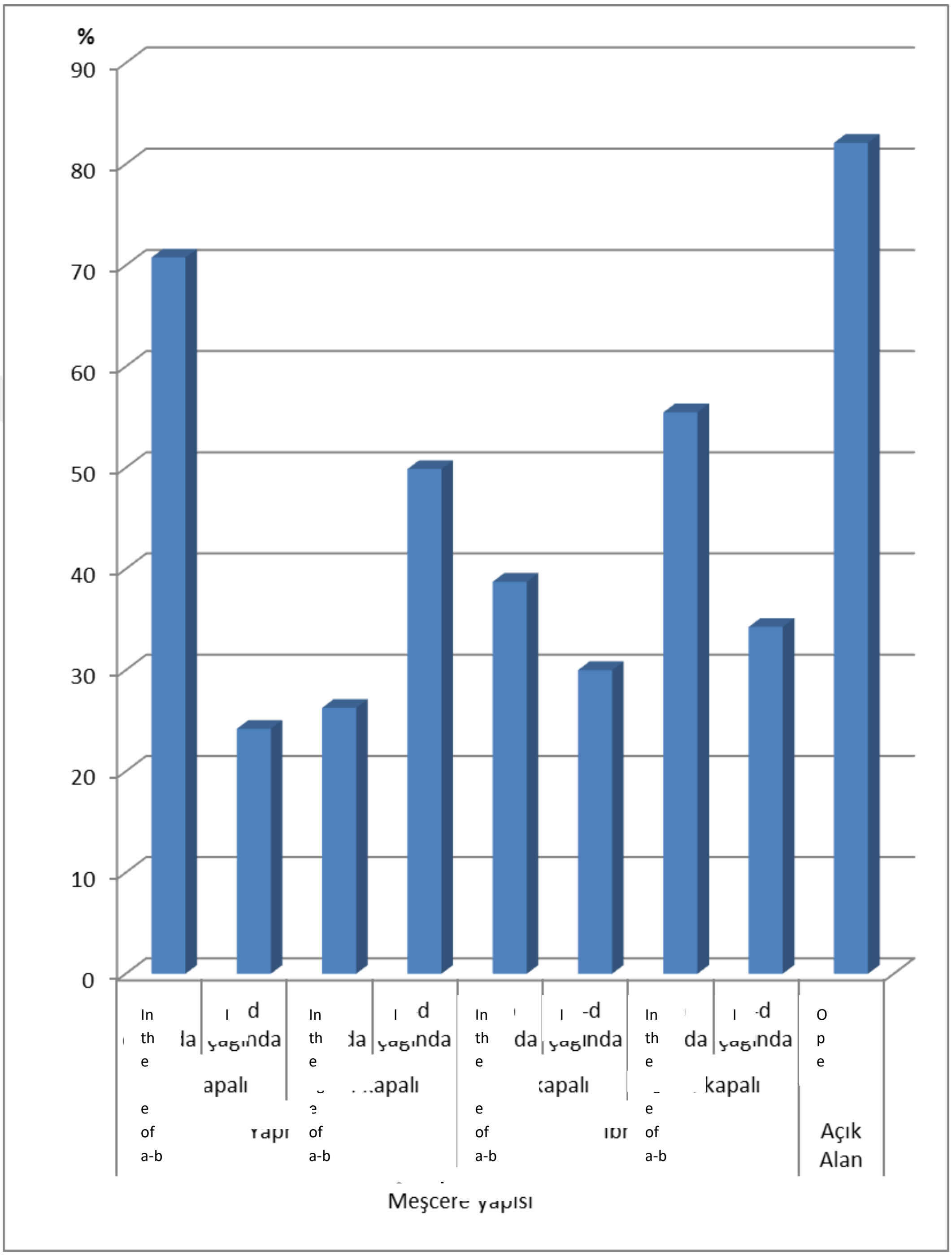

Figure 4.26. The effect of stand structure on the amount of PM2 size dust at 20 m distance

When the effect of stand structure on PM3 is examined, it is seen that there is no statistically significant difference between the data at least at 95% confidence level.

Therefore Duncan test was not applied to the data. This result can be interpreted as the limited transport of heavy dust over long distances. The graph shows the effect of stand structure on the amount of PM3 sized dust at 20 m distance is given in Figure 4.27.

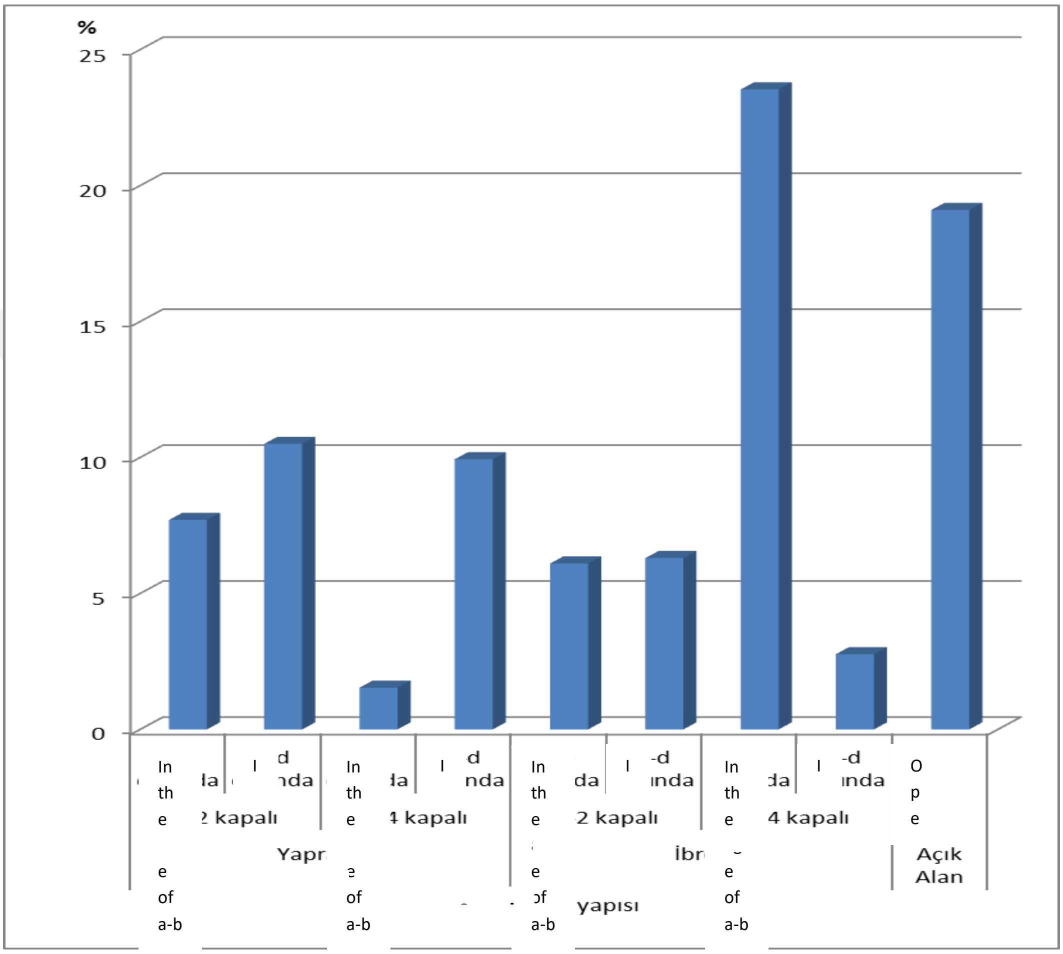

Figure 4.27. The effect of stand structure on the amount of PM3 sized dust at 20 m distance

5. RESULTS AND DISCUSSION

The contributions of forests to society, human and wild life health quiet important as well as their being a source of wood raw materials. Noise pollution and PM pollution are the most commonly disturbing types of environmental pollution. starting from this point of view, as the result of this study it was revealed that the forests are qualified to filter and absorb the dust and the noise in the environment.

While noise reduction effect of forest vegetation was determined within the scope of study, first, sound measurements were made at determined points in the study area and sound measurements were made in silent environment, and later net sound value and proportional values were calculated. It has been determined that forest structures that reduce the net sound value to the lowest level, namely, the forests which reduce the noise mostly, were the closed young coniferous stands in 10 m distance, and that these stands reduce the noise level to 40.886% of the initial level within 10 m distance. The second most effective stands to reduce the noise level were the semi-closed young coniferous stands which reduced the noise level to 47,023% of the initial level within 10 m distance.

At 25 m distance, the most effective stand was again the closed young coniferous stands, which reduced the amount of noise to 16. 7% of initial level, namely absorbed the 83.3% of the noise. The closed young coniferous which was determined to be the most effective stand type to absorb the noise, absorbed the 98% of the noise and reduced it 2,133% of the initial noise in 50m distance as well.

Noise has negative effects on hearing sense as well as it has psychological and physiological effects (Bayraktar, 2006). Noise causes very mild Hearing loss at level of 27-40 dB (A), slight hearing loss at a level of 41-55 dB (A), medium level hearing loss at a level of 56-70 dB (A), high degree hearing loss at a level of 71-90 dB and the highest degree hearing loss if the noise level is more than 91 dB (Cetin, 2000).

Due to noise has this much effect on people, numerous studies have been conducted on noise. Many of the studies conducted on this subject is focused on determining the amount of noise, especially in residential areas. Çetin (2010) in Denizli; Kumbur et al (2006) in Mersin; Şener et al., (2008) in Isparta; Yilmaz and Hoçanlı (2008) in Şanlıurfa, Nas et al., (2004) in Konya; Deveci (2004) in Edirne; Uslu and Yücel (1997) and Kahraman (2002) in Adana; Aktürk et al., (2003) in Ankara; Akgüngör and Demirel (2008) in Kırıkkale; Özyonar and Peker (2008) in Sivas; Mazzuckelli et al. (2006) in Nigeria; Ruggiero et al. (2016) in Italy; Zannin et al. (2002) in Brazil; Hunashal et al. (2012) in India, Mehdi et al. (2011) in Pakistan, Morillas et al. (2002) in Spain determined the noise pollution.

After determining the effects on human health, numerous studies have been conducted to reduce the noise level as well. In order to reduce the noise level, the changes that can be made on the vehicles and on the road surface structure have been examined and it has been determined that the noise level can be reduced by traffic regulation (Toklu, 2011). However, the most effective method that can be used to reduce noise is undoubtedly the avoidance of the noise by the structures in environment.

In order to use the plant material for noise prevention effectively; it is necessary to know which material should be chosen and how to use it. Trees and shrubs with dense leaf structure absorb and reflect more noise. Additionally, as the thickness, height and density of plants increase their effect on noise prevention also increases (Knudsen 1978). For plants to be used effectively for this purpose, they must be spread over as wide a space as possible and reach a height of at least 5 m. Gallion and Eisner (1986) stated that the length of planting area for noise should be at least 7.5 m or more, and plants should be at a sufficient height.

Alparslan (1987) reported that reduction in noise level by using plant material changes depending on leaf size, leaf situation, leaf and needle density and branching, and that the effectiveness of plants on noise prevention depends on plant’s structure rather than their width. Features required for plants to be used for noise reduction are, large and hard leaves, the arrangement of the leaves vertically to the sound direction and in form of covering one another, dense leaf and branch structure from the top to the ground, to be evergreen, to form frequent seals and to be high in length with all these features (Finke, 1980). The closed young coniferous stands which were determined to prevent the noise most effectively are the stands that exactly meet these conditions.

Within the scope of the study the effect of forest structure on dust amount was evaluated and as a result of the measurements and calculations conducted it was determined that while 76,267 % of the dust in size of PM1 could reach to 10 m distance in open spaces; this ratio was 41,6 % in young closed leafy stands and at about 44% in young closed coniferous stands. As for dust in size of PM2; 27,93% of the dust could reach to 10 m distance in closed mature leafy stands, while this ratio was 35% in semi-closed mature leafy stands, 35,3% young closed leafy stands and 40,47% in young closed coniferous stands. There is no statistically significant difference between these values at least at 95% confidence level.

While 27.67% of the dust in size PM3, which is the largest size of the dust, could reach to 10 m distance in open spaces, this ratio varies between 3.90% and 15.13% in forest areas. However, there is no statistically significant difference at least at 95% confidence level between these values. Therefore, depending on this data; it can be said that all the stand structures subjected to this study are effective on PM3 sized dusts. However, it was determined that the most effective stands were young closed coniferous stands and only 3.9% of PM3 sized dusts could reach to 10 m distance in these forests. Therefore, when all the results are evaluated together, it can be stated that the most effective stands on the amount of dust are the young closed coniferous stands.

Particulates occur from natural sources such as wind, sea, and volcanoes, or from anthropogenic sources of activity, and are suspensions of thin solid or liquid substances in a gas. It is generally referred to as aerosol in the literature (Özdemir et al., 2010). It is stated that exposure to particulate matter accelerates heart rate in people with heart disease, asthma, heart and lung patients are affected negatively, even if they are exposed to large particulate matter for a short period of time (Sivaslıgil, 2007).

The effects of particulate matter on human health can be summarized as briefly rising respiratory symptoms and airway irritation, coughing or difficulty in breathing, diminished pulmonary function, severe asthma, chronic bronchitis, heart attacks, irregular heartbeats and realted symptoms (Sivaslıgil, 2007). These are direct effects of particulate matter. Besides these effects, it is known that particulate matter constitutes a host or pharyngeal center for other factors, which are particularly dangerous to health, so that the negative effects of particulate matters on health can reach much more dangerous dimensions. For example; particulate matter accumulates heavy metals on themselves, and it is stated that heavy metals also enter the body as a result of taking these particulate matters through the respiratory tract. Heavy metals such as Hg, Cd, As and Pb are toxic to organisms at even very low amounts (Shahid et al., 2017; Turkyilmaz et al., 2018a,b; Cetin et al., 2017; Isinkaralar et al., 2017). On December 5-9, 1952, about 4,000 people died in London as a result of respiratory illnesses such as pneumonia and bronchitis, and the next few months the effects of polluted air caused about 8000 more deaths (Chris Deziel, 2016). Samples from the victims showed that their lungs were contaminated by very high levels of very small particles containing heavy metals such as Pb, Zn and Fe (Shahid et al., 2017).

A number of studies have been carried out in this regard, following the realization of the direct or indirect effects of particulate matter on human health. The quantities of particulate matter in various regions were determined by the studies conducted. Zhang and Cao (2015) in China; Sgrigna et al. (2015) in Italy; Mastroianni et al. (2015) in Spain; Johnson et al. (2016) in the United States; Nourmorad et al (2015) in Iran, Cetin and Şevik (2016) in Turkey, Rushdi et al. (2017) in Saudi Arabia and Lu et al. (2017) studied in determination of the amount of particulate matter in Taiwan.

Both live and inanimate materials can be used both to reduce the particulate matters and to prevent the noise. Non-living materials offer advantages such as space-saving, being more effective, showing immediate effects, having no special land or space requirements (Unver, 2008).

The advantages that living materials offer are much more. First of all, live materials, ie plants, contribute to sustain the natural stabilization and enhance biological and ecological diversity. A system of living materials doesn’t have the risk of degradation and destruction due to the influence of the climate and time like a system formed by inanimate. Conversely, time and climate are factors favoring plant material (Unver, 2008).

Plants also perform many ecological, economical and social functions in their growing environment. Plants add aesthetic values to their growing environment (Cetin, 2015a) and enable psychologically positive effects (Cetin, 2015b). They contribute to people to work more productively (Djukanovic, 2002; Chang and Chen, 2005; Cetin, 2016). They effect the human health positively by reducing the contamination factors such as particulate matter, CO_2, and heavy meatls in the air as well as the noise in the environment (Tani and Hewitt, 2009; Papinchak et al.,2009; Sevik et al.,2016a). They provide the production of economically valuable primary and secondary products (Sevik, 2011; Sevik, 2012). Apart from these, they perform many other secondary functions such as erosion and slaughter prevention, providing shelter and food for wild animals (Cetin et al., 2017). In addition, although the initial cost of a noise barrier made with live materials is high, it is more economical when considering the continuity and the effect over time (Ünver, 2008).

REFERENCES

Abbaspour, M., Karimi, E., Nassiri, P., Monazzam, M. R., & Taghavi, L. (2015). Hierarchal assessment of noise pollution in urban areas–A case study. *Transportation Research Part D: Transport and Environment, 34,* 95-103.

Affenzeller, J., & Rust, A. (2005). Road Traffic Noise- a Topic for Today and the Future, VDA. Technical Congress, Ingolstadt, Germany.

Akgüngör, A. P., & Demirel, A. (2008). Investigating urban traffic based noise pollution in the city of Kirikkale, Turkey. *Transport*, *23*(3), 273-278.

Aktürk, N., Akdemir, O., & Üzkurt, İ. (2003). Trafik Işık Sürelerinin Neden Olduğu Çevresel Taşıt Gürültüsü. *Gazi Üniversitesi Mühendislik-Mimarlık Fakültesi Dergisi*, *18*(1).

Alparslan, E. (1987). Karayollarında Gürültüye Karşı Peyzaj Mimarlığı Açısından Alınabilecek Önlemler. *Dokuz Eylül Üniversitesi Mühendislik Mimarlık Fakültesi Şehir ve Planlama Bölümü Semineri, İzmir, PP, 13.*

Anderson, J. O., Thundiyil, J. G., & Stolbach, A. (2012). Clearing the air: a review of the effects of particulate matter air pollution on human health. *Journal of Medical Toxicology, 8*(2), 166-175.

Başar, P., Okyay, P., Ergin, F., Coşan, S., & Yıldız, A. (2005). Aydın ili kent merkezinde hava kirliliği/1997-2004.

Batu, F. (1995). *Uygulamalı istatistik yöntemler*. Karadeniz Teknik Üniversitesi.

Bayraktar, Ş., (2006). İzmir Kent Merkezinin Gürültü Kirliliği, Yüksek Lisans Tezi, *Kocaeli Üniversitesi, Fen Bilimleri Enst*. Kocaeli.

Bayram, H., Dörtbudak, Z., Fişekçi, F. E., Kargın, M., & Bülbül, B. (2006). "Hava Kirliliğinin İnsan Sağlığına Etkileri, Dünyada, Ülkemizde ve Bölgemizde Hava Kirliliği Sorunu" Paneli Ardından. *Tıp Dergisi*, *33*, 105-12.

Bayramoğlu, E., Işık, B.Ö. & Demirel, Ö.(2014). Gürültü Kirliliğinin kent parklarına etkisi ve çözüm önerileri: Trabzon kenti örneği, İnönü Üniversitesi Sanat ve Tasarım Dergisi, 4(9), 35-42.

Bilgili, S., Gürtepe, E., Türkel, E., Altınoluk, A. M., Hüsmen, N., Bütün A., & Ertorun H.(2011). Çevresel Gürültü Ölçüm ve Değerlendirme Klavuzu, T.C. Çevre ve Orman Bakanlığı Çevre Yönetimi Genel Müdürlüğü.

Branco, P. T. B. S., Alvim-Ferraz, M. C. M., Martins, F. G., & Sousa, S. I. V. (2014). Indoor air quality in urban nurseries at Porto city: Particulate matter assessment. *Atmospheric environment*, *84,* 133-143.

Buxton, O. M., Ellenbogen, J. M., Wang, W., Carballeira, A., O'connor, S., Cooper, D., & Solet, J. M. (2012). Sleep disruption due to hospital noises: a prospective evaluation. *Annals of internal medicine*, *157*(3), 170-179.

Canepari, S., Perrino, C., Olivieri, F., & Astolfi, M. L. (2008). Characterisation of the traffic sources of PM through size-segregated sampling, sequential leaching and ICP analysis. *Atmospheric Environment*, *42*(35), 8161-8175.

Cetin, M. (2015a). Determining the bioclimatic comfort in Kastamonu City. *Environmental Monitoring and Assessment, 187* (10), 640.

Cetin M. (2015b) Using GIS Analysis to Assess Urban Green Space in Terms of Accessibility: Case Study in Kutahya. *Int. J. Sust. Dev. World, 22* (5), 420.

Cetin, M. (2016). A Change in the Amount of CO2 at the Center of the Examination Halls: Case Study of Turkey. *Studies on Ethno-Medicine*, *10*(2), 146-155.

Cetin, M. & Sevik, H. (2016). Measuring the Impact of Selected Plants on Indoor CO2 Concentrations. *Polish Journal of Environmental Studies*, *25*(3), 973-979.

Cetin M., Sevik H. & Isınkaralar, K. (2017). Changes in the Particulate Matter and CO2 Concentrations Based on the Time and Weather Conditions: The Case of Kastamonu. *Oxidation Communications, 40* (1-II), 477-485.

Chang, C. H., & Chen, J. H. (2005). Taxonomic status and intraspecific phylogeography of two sibling species of Metaphire (Oligochaeta: Megascolecidae) in Taiwan. *Pedobiologia*, *49*(6), 591-600.

Chen, L. C., & Lippmann, M. (2009). Effects of metals within ambient air particulate matter (PM) on human health. *Inhalation toxicology*, *21*(1), 1-31.

Çetin, F. (2010). Denizli İli Trafik Gürültü Kirliliği Haritası. Yüksek Lisans Tezi, *Celal Bayar Üni, Sağlık Bilimleri Enst.* Manisa.

Çimen, M., & Öztürk, S. (2010). Küresel Isınma, İklim Değişikliğinin Solunum Sistemi Üzerine Etkisi ve Büyükşehir Bronşiti. *Fırat Üniversitesi Sağlık Bilimleri Tıp Dergisi*, *24*(2), 141-146.

Davidson, C. I., Phalen, R. F., & Solomon, P. A. (2005). Airborne particulate matter and human health: a review. *Aerosol Science and Technology*, *39*(8), 737-749.

Deveci, S. (2004). Edirne ilinde gürültü düzeylerinin belirlenerek gürültü haritalarının oluşturulması. *Tıpta Uzmanlık Tezi, Trakya Üniversitesi*.

Djukanovic, R. Wargocki, P. & Fanger, P.O. (2002). Cost-Benefit Analysis of Improved Air Quality in an Office Building. *Proceedings of Indoor Air, 2002*(1), 808-813.

Dockery, D. W. (2009). Health effects of particulate air pollution. *Annals of epidemiology*, *19*(4), 257-263.

Doğan, F., & Kitapçıoğlu, G. (2007). İzmir ilinde hava kirliliğinin yıllar itibariyle karşılaştırılması. *Ege Tıp Dergisi*, *46*(3), 129-133.

Dorjsuren, U. (2012). İstanbul Üniversitesi Avcılar Yerleşkesi'nde Solunabilir Partikül Maddenin Boyut Dağılımının Ve Element İçeriğinin İncelenmesi. Yüksek Lisans Tezi, *İstanbul Üniversitesi, Fen Bilimleri Enstitüsü.* İstanbul.

Doygun, H., & Gurun, D. K. (2008). Analysing and mapping spatial and temporal dynamics of urban traffic noise pollution: a case study in Kahramanmaraş, Turkey. *Environmental Monitoring and Assessment*, *142*(1-3), 65-72.

Dubinskaya, A. M. (1998). Mechanochemical transformation in organic substances // Chem. Rev. ñ Vol. 23. ñ P. 201ñ261

Eğri, M. (1997). 1996-1997 kış döneminde Malatya il merkezi hava kirliliği parametrelerine meteorolojik koşulların etkisi. *Turgut Özal Tıp Merkezi Dergisi*, *4*(3).

Elbir, T., Mangir, N., Kara, M., Simsir, S., Eren, T., & Ozdemir, S. (2010). Development of a GIS-based decision support system for urban air quality management in the city of Istanbul. *Atmospheric Environment*, *44*(4), 441-454.

Erdoğan, A. (2016). Denizli'de üç tekstil fabrikasındaki gürültü düzeyinin çalışanlar üzerine etkisi. http://acikerisim.pau.edu.tr/xmlui/handle/11499/1112 .

Fiedler, P. E. K., & Zannin, P. H. T. (2015). Evaluation of noise pollution in urban traffic hubs—Noise maps and measurements. *Environmental Impact Assessment Review*, *51*, 1-9.

Gallion, A. B., & Eisner, S. (1986). The urban pattem. *City Planning and Design*.

Geravandi, S., Takdastan, A., Zallaghi, E., Niri, MV., Mohammadi, MJ., , H., & Naiemabadi, A, (2015d). Noise pollution and health effects. Jundishapur Journal of Health Sciences 7(1):e25357

Güngör, A. (2013). Isparta İlindeki Atmosferde Bulunan Kükürtdiksit (So2) Ve Partikül Madde (Pm) Konsantrasyonunun Çoklu Doğrusal Regresyon Yöntemi İle Modellenmesi. Yüksek Lisans Tezi, *Süleyman Demirel Üni, Fen Bilimleri Enst.* Isparta.

Harrison, R. M., & Yin, J. (2000). Particulate matter in the atmosphere: which particle properties are important for its effects on health?. *Science of the total environment*, *249*(1-3), 85-101.

Hazar, S. (2017). Effects of sound level on postural stability Ses seviyesinin denge performansına etkisi. *Journal of Human Sciences*, *14*(1), 217-224.

Hunashal, R. B., & Patil, Y. B. (2012). Assessment of noise pollution indices in the city of Kolhapur, India. *Procedia-Social and Behavioral Sciences*, *37,* 448-457.

Isinkaralar, O., Isinkaralar, K., Ekizler, A. & Ilkdogan, C., (2017). Changes in the Amounts of CO2 and Particulate Matter in Kastamonu Province Depending on Weather Conditions and Locations. *Journal of Chemical, Biological and Physical Sciences*, *7*(3), 643-650

Jin, Y., Xu, W., Xu, M., & Fang, T. (2005). Stochastic resonance in linear system due to dichotomous noise modulated by bias signal. *Journal of Physics A: Mathematical and General*, *38*(17), 3733.

Kahraman, Y. (2002). Adana İli Merkezinde Gürültü Kirliliğinin Değerlendirilmesi. Uzmanlık Tezi, *Çukurova Üniversitesi Tıp Fakültesi*. Adana.

Karaca, F. (2008). Büyükçekmece Havza Atmosferindeki PM 2.5 ve PM 10 Partikül Gruplarındaki Metallerin İstatistik Dağılım Özelliklerinin İncelenmesi. *Ekoloji Dergisi*, *17*(68).

Kim, K. H., Kabir, E., & Kabir, S. (2015). A review on the human health impact of airborne particulate matter. *Environment international*, *74*, 136-143.

Knudsen, E. I., & Konishi, M. (1978). A neural map of auditory space in the owl. *Science*, *200*(4343), 795-797.

Kulaç, Ş., & Yıldız, Ö. (2016). Effect of Fertilization on the Morphological Development of European Hophormbeam (Ostrya carpinifolia Scop.) Seedlings. *Turkish Journal of Agriculture-Food Science and Technology*, *4*(10), 813-821.

Kumbur, H., Özer, Z., & Avcı, D. E. (2006). Mersin üniversitesi Çiftlikköy Kampüsü Gürültü Seviyelerinin CBS (Coğrafi Bilgi Sistemi) ile Analizi. *Coğrafi Bilgi Sistemleri Bilişim Günleri*, 13-16.

Li, H., Wang, R., Cao, S., Chen, Y., & Huang, W. (2016). A method for low-frequency noise suppression based on mathematical morphology in microseismic monitoring. *Geophysics*, *81*(3), V159-V167.

Louie, P. K., Watson, J. G., Chow, J. C., Chen, A., Sin, D. W., & Lau, A. K. (2005). Seasonal characteristics and regional transport of PM2. 5 in Hong Kong. *Atmospheric Environment*, *39*(9), 1695-1710.

Lu, M. C., Wang, P., Cheng, T. J., Yang, C. P., & Yan, Y. H. (2017). Association of temporal distribution of fine particulate matter with glucose homeostasis during pregnancy in women of Chiayi City, Taiwan. *Environmental research*, *152*, 81-87.

Matějíček, L., Engst, P., & Jaňour, Z. (2006). A GIS-based approach to spatio-temporal analysis of environmental pollution in urban areas: A case study of Prague's environment extended by LIDAR data. *Ecological Modelling*, *199*(3), 261-277.

Mehdi, M. R., Kim, M., Seong, J. C., & Arsalan, M. H. (2011). Spatio-temporal patterns of road traffic noise pollution in Karachi, Pakistan. *Environment international*, *37*(1), 97-104.

Merchan, C. I., Diaz-Balteiro, L., & Soliño, M. (2014). Noise pollution in national parks: Soundscape and economic valuation. *Landscape and Urban Planning*, *123*, 1-9.

Morillas, J. B., Escobar, V. G., Sierra, J. M., Gómez, R. V., & Carmona, J. T. (2002). An environmental noise study in the city of Cáceres, Spain. *Applied acoustics*, *63*(10), 1061-1070.

Mutlu, A., İrdem, İ., & Üre, B. (2015). Ekolojik Mültecilik. *Memleket Siyaset ve Yönetim Dergisi*, *10*(23).

Müezzinoğlu, A. (1987). *Hava kirliliğinin ve kontrolünün esasları*. İzmir: Dokuz Eylül Üniversitesi Yayınları.

Nas, B., Berktay, A., Ertuğrul, T., Aygün, A., & Işık, M. (2004). Konya kenti yol trafik gürültüsü seviyeleri'nin coğrafi bilgi sistemleri (CBS) ile görüntülenmesi, 3. *Coğrafi Bilgi Sistemleri Bilişim Günleri, Konya*.

Ologe, F. E., Okoro, E., & Oyejola, B. A. (2006). Case Study: Environmental Noise Levels in Nigeria: A Report. *Journal of occupational and environmental hygiene*, *3*(2), D19-D21.

Oruç, Ş. K. (2017). Hızlı Trenin Neden Olduğu Çevresel Gürültü Kirliliği. Yüksek Lisans Tezi, *Gazi Üniversitesi Fen Bilimleri Enstitüsü*. Ankara.

Ögel, C. (2015). Isparta Şehrinde Trafik Kaynaklı Gürültü Kirliliği. Yüksek Lisans Tezi, *Ondokuz Mayıs Üniversitesi Sosyal Bilimler Enstitüsü.* Samsun.

Özdemir, H., Borucu, G., Demir, G., Yiğit, S., & Ak, N. (2010). İstanbul'daki çocuk oyun parklarında partikül madde (PM2, 5 ve PM10) kirliliğinin incelenmesi. *Ekoloji*, *20*(77), 72-79.

Özyonar, F., & Peker, İ. (2008). Sivas Kent Merkezindeki Çevresel Gürültü Kirliliğginin Araştırılması. *Ekoloji Dergisi*, *17*(69).

Papinchak, H., Holcomb, E. J., Orendovici, B. T. & Decoteau, D. R. (2009). Effectiveness of houseplants in reducing the indoor air pollutant ozone. *HortTechnol. 19* (2), 286-290.

Police, S., Sahu, S. K., & Pandit, G. G. (2016). Chemical characterization of atmospheric particulate matter and their source apportionment at an emerging industrial coastal city, Visakhapatnam, India. *Atmospheric Pollution Research*, *7*(4), 725-733.

Pope III, C. A. (2000). Epidemiological basis for particulate air pollution health standards. *Aerosol Science & Technology*, *32*(1), 4-14.

Ruggiero, A., Russo, D., & Sommella, P. (2016). Determining environmental noise measurement uncertainty in the context of the Italian legislative framework. *Measurement*, *93*, 74-79.

Rushdi, A. I., El-Mubarak, A. H., Lijotra, L., Al-Otaibi, M. T., Qurban, M. A., Al-Mutlaq, K. F., & Simoneit, B. R. (2017). Characteristics of organic compounds in aerosol particulate matter from Dhahran city, Saudi Arabia. *Arabian Journal of Chemistry*, *10*, S3532-S3547.

Saraç, K. T. H. (2015). Türkiye'deki Partikül Madde Verilerinin Değerlendirilmesi. Yüksek Lisans Tezi*, Atatürk Üniversitesi, Fen Bilimleri Enstitüsü*. Erzurum.

Scherbakova, K. (2010). İstanbul'daki Solunabilir Partikül Maddenin Boyut Dağılımının İstatistiksel Analizi. Yüksek Lisans Tezi, *İstanbul Üniv. Fen Bilimleri Enst.* İstanbul.

Sevık, H. (2012). Variation in seedling morphology of Turkish fir (Abies nordmanniana subsp. bornmulleriana Mattf). *African Journal of Biotechnology*, *11*(23), 6389-6395.

Sevik, H., Karakaş, H. & Karaca, Ü. (2013). Color - Chlorophyll relationship of some indoor ornamental plant, *International Journal of Engineering Science & Research Technology, 2*(7), 1706-1712.

Sevik, H., Cetin, M., Belkayali, N. & Guney, K. (2016). The Effect of Plants on Indoor Air Quality, Environmental Sustainability and Landscape Management, ISBN:978-954-07-4140-6, Chapter 8, p:138-149, St. Kliment Ohridski University Press, Sofia

Sgrigna, G., Sæbø, A., Gawronski, S., Popek, R., & Calfapietra, C. (2015). Particulate Matter deposition on Quercus ilex leaves in an industrial city of central Italy. *Environmental pollution, 197,* 187-194.

Sgrigna, G., Baldacchini, C., Esposito, R., Calandrelli, R., Tiwary, A., & Calfapietra, C. (2016). Characterization of leaf-level particulate matter for an industrial city using electron microscopy and X-ray microanalysis. *Science of the Total Environment, 548,* 91-99.

Shahid, M., Dumat, C., Khalid, S., Schreck, E., Xiong, T., & Niazi, N. K. (2017). Foliar heavy metal uptake, toxicity and detoxification in plants: A comparison of foliar and root metal uptake. *Journal of hazardous materials, 325,* 36-58.

Sivaslıgil, A. (2007). Gebze Dilovasi'nda partikül madde kirliliği; kirletici kaynaklarin dökümü ve partikül madde kanserojenik PAH analizi, Y. Yüksek Lisans Tezi*, Gebze Yüksek Teknoloji Enstitüsü,* Gebze.

Şener, E., Morova, N., Polat, E., Terzi, S., & Serin, S. (2008). Kentiçi Trafikten Kaynaklanan Gürültülerin Coğrafi Bilgi Sistemleri İle Haritalandırılması: Isparta Kenti Örneklemesi. *II. Uzaktan Algılama ve Coğrafi Bilgi Sistemleri Sempozyumu,* 656-667.

Şevik, H. (2011). Dallanma Karakterleri Bakımından Noel Ağacı Üretimine Uygun Uludağ Göknarı Populasyonlarının Belirlenmesi. *Kastamonu Üniversitesi, Orman Fakültesi Dergisi, 11*(1), 102-107.

Tankut, A. N., Kurban, H., & Melemez, K. (2014). Orman Endüstri İşletmelerinde Odun Tozunun Ergonomik Etkilerinin İncelenmesi. II. *Ulusal Akdeniz Orman Ve Çevre Sempozyumu,* 22-24.

Tani, A., & Hewitt, C. N. (2009). Uptake of aldehydes and ketones at typical indoor concentrations by houseplants. *Environmental science & technology, 43*(21), 8338-8343.

Toklu, S. (2011). Motorlu Araçlardan Kaynaklanan Gürültü Kirliliği: Bir Bölge Çalışması. Yüksek Lisans Tezi, *Gazi Üniversitesi Fen Bilimleri Enstitüsü*. Ankara.

Turkyilmaz, A., Sevik, H., Cetin, M. & Saleh, E. A. A. (2018a) Changing of Heavy Metal Accumulation Dependent on Traffic Density in Some Landscape Plants, *Polish Journal of Environmental Studies (InPress).*

Turkyilmaz, A., Sevik, H. & Cetin, M. (2018b) The use of perennial needles as biomonitors for recently accumulated heavy metals. *Landscape and Ecological Engineering, (InPress)* DOI: 10.1007/s11355-017-0335-9.

Tüncel, B. (2016). Kocaeli - Dilovası Bölgesi' Nden Kaynaklanan Partikül Madde Ve Kükürt Dioksit Emisyonlarının Iscst3 Yazılımı Kullanılarak

Modellenmesi. Yüksek Lisans Tezi, *Gebze Teknik Üniversitesi, Fen Bilimleri Enstitüsü.* Gebze.

Ulutaş, K. (2010). Gebze Ortam Havasındaki Partikül Maddenin Ağır Metal İçeriğinin İncelenmesi. Yüksek Lisans Tezi, *Gebze İleri teknoloji Enstitüsü*. Gebze.

URL-1. TUİK, Nüfus İstatistikleri, 25/01/2018 tarihinde http://www.tuik.gov.tr/UstMenu.do?metod=temelist adresinden alınmıştır.

Uslu, C., & Yücel, M. (1997). Adana kentinde gürültü kirliliği üzerine bir araştırma. *Ekoloji*, *7*(25), 9-13.

Ünver, E. (2008). Trafik Ve Rekreasyonel Kullanım Kaynaklı Gürültü Kirliliğinin Belirlenmesi: Çorlu Örneği Yüksek Lisans Tezi, *Namık Kemal Üni, Fen Bilimleri Enst*. Tekirdağ.

Valavanidis, A., Fiotakis, K., & Vlachogianni, T. (2008). Airborne particulate matter and human health: toxicological assessment and importance of size and composition of particles for oxidative damage and carcinogenic mechanisms. *Journal of Environmental Science and Health, Part C*, *26*(4), 339-362.

Watson, J. G., Chow, J. C., & Chen, L. W. A. (2005). Summary of organic and elemental carbon/black carbon analysis methods and intercomparisons. AAQR, 5 (1): 65-102.

Wiseman, C. L., & Zereini, F. (2009). Airborne particulate matter, platinum group elements and human health: a review of recent evidence. *Science of the Total Environment*, *407*(8), 2493-2500.

Yalçın, İ., E. (2013). İstanbul'da *Pınus Brutıa* Ten. (*Pınaceae*)'de Ağır Metal Birikimi Ve Habitatında Partikül Madde (PM) Ölçümleri. Yüksek Lisans Tezi, *Marmara Üni. Fen Bilimleri Enst*. İstanbul.

Yatkin, S., & Bayram, A. (2007). Elemental composition and sources of particulate matter in the ambient air of a Metropolitan City. *Atmospheric Research*, *85*(1), 126-139.

Yılmaz, G., & Hoçanlı, Y. (2008). Şanlıurfa ili gürültü kirliliği haritası. *Çevre Sorunları Sempozyumu, Kocaeli*.

Yüksel, H. (2008). An empirical evaluation of cleaner production practices in Turkey. *Journal of Cleaner Production*, *16*(1), S50-S57.

Zannin, P. H. T., Diniz, F. B., & Barbosa, W. A. (2002). Environmental noise pollution in the city of Curitiba, Brazil. *Applied Acoustics*, *63*(4), 351-358.

Zhang, Y. L., & Cao, F. (2015). Fine particulate matter (PM 2.5) in China at a city level. *Scientific Reports, 5*, 14884.

ATTACHMENTS

Attachment 1. Measurement Data of PM

Stand Type Codes:	Size of PM :	Distance Code:
1= Open Area	1 = 0.3	1 = 0 metre
2 = Leafy,1-2 Closed , a-b Age of development	2 = 0.5	2 = 10 metre
3 = Yapraklı, 1-2 Closed, c-d Age of development	3 = 5	3 = 20 metre
4 = Coniferous,3-4 Closed, c-d Age of development		
5 = Coniferous, 1-2 Closed, a-b Age of development		
6 = Leafy, 3-4 Closed, a-b Age of development		
7 = Leafy, 3-4 Closed, c-d Age of development		
8 = Coniferous, 1-2 Closed, c-d Age of development		
9 = Coniferous, 3-4 Closed, a-b Age of development		

Number of measurements	Stand Type Code	Distance Code	Size of PM	PM
1	1	1	1	119643
2	1	1	1	143873
3	1	1	1	185799
4	1	1	2	39970
5	1	1	2	66609
6	1	1	2	109915
7	1	1	3	8939
8	1	1	3	17852
9	1	1	3	34304
10	1	3	1	112697
11	1	3	1	106041
12	1	3	1	178296
13	1	3	2	81441
14	1	3	2	63352
15	1	3	2	107247
16	1	3	3	2841
17	1	3	3	2595
18	1	3	3	3757
19	2	1	1	243030
20	2	1	1	93370
21	2	1	1	138831
22	2	1	2	220731
23	2	1	2	62209
24	2	1	2	110526
25	2	1	3	101986
26	2	1	3	16420

Attachment 1 (Continued)

27	2	1	3	37819
28	2	3	1	146477
29	2	3	1	85493
30	2	3	1	103969
31	2	3	2	68399
32	2	3	2	56385
33	2	3	2	100252
34	2	3	3	1793
35	2	3	3	1910
36	2	3	3	3664
37	3	1	1	150076
38	3	1	1	170243
39	3	1	1	133709
40	3	1	2	82956
41	3	1	2	103051
42	3	1	2	57945
43	3	1	3	24792
44	3	1	3	35070
45	3	1	3	15032
46	3	3	1	84888
47	3	3	1	50579
48	3	3	1	73038
49	3	3	2	17059
50	3	3	2	25680
51	3	3	2	15730
52	3	3	3	1670
53	3	3	3	3172
54	3	3	3	2376
55	4	1	1	181898
56	4	1	1	144923
57	4	1	1	161543
58	4	1	2	122190
59	4	1	2	88902
60	4	1	2	107538
61	4	1	3	52742
62	4	1	3	30919
63	4	1	3	40257
64	4	3	1	74521
65	4	3	1	52830
66	4	3	1	61192
67	4	3	2	48799
68	4	3	2	23543

Attachment 1 (Continued)

69	4	3	2	39197
70	4	3	3	1761
71	4	3	3	629
72	4	3	3	1204
73	5	1	1	189794
74	5	1	1	230023
75	5	1	1	159489
76	5	1	2	149553
77	5	1	2	190699
78	5	1	2	109784
79	5	1	3	41491
80	5	1	3	69306
81	5	1	3	37145
82	5	3	1	79284
83	5	3	1	59832
84	5	3	1	85797
85	5	3	2	59827
86	5	3	2	38195
87	5	3	2	61727
88	5	3	3	3341
89	5	3	3	3276
90	5	3	3	2051
91	6	1	1	74861
92	6	1	1	154564
93	6	1	1	137555
94	6	1	2	41480
95	6	1	2	124993
96	6	1	2	109996
97	6	1	3	13373
98	6	1	3	40992
99	6	1	3	34904
100	6	3	1	42504
101	6	3	1	50705
102	6	3	1	64469
103	6	3	2	12201
104	6	3	2	20529
105	6	3	2	36263
106	6	3	3	133
107	6	3	3	438
108	6	3	3	880
109	7	1	1	140858
110	7	1	1	136978

Attachment 1 (Continued)

111	7	1	1	147269
112	7	1	2	62225
113	7	1	2	33887
114	7	1	2	57164
115	7	1	3	17692
116	7	1	3	10263
117	7	1	3	20796
118	7	3	1	66789
119	7	3	1	56821
120	7	3	1	73521
121	7	3	2	20581
122	7	3	2	19121
123	7	3	2	34380
124	7	3	3	1061
125	7	3	3	1270
126	7	3	3	2378
127	8	1	1	148615
128	8	1	1	165411
129	8	1	1	168915
130	8	1	2	94543
131	8	1	2	119076
132	8	1	2	117884
133	8	1	3	34898
134	8	1	3	35949
135	8	1	3	35024
136	8	3	1	45427
137	8	3	1	59469
138	8	3	1	51609
139	8	3	2	20911
140	8	3	2	40875
141	8	3	2	39638
142	8	3	3	1402
143	8	3	3	3054
144	8	3	3	2256
145	9	1	1	140668
146	9	1	1	332213
147	9	1	1	116072
148	9	1	2	65465
149	9	1	2	283547
150	9	1	2	40636
151	9	1	3	20449
152	9	1	3	125165

Attachment 1 (Continued)

153	9	1	3	6107
154	9	3	1	77230
155	9	3	1	45699
156	9	3	1	88423
157	9	3	2	51219
158	9	3	2	16060
159	9	3	2	63537
160	9	3	3	2729
161	9	3	3	353
162	9	3	3	3483

Attachment 2. Measurement Data of NP

	Open Area							
	0_m		**10_m**		**25_m**		**50_m**	
Number of Measurement	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**
1	49,3	101,8	52,6	88,7	52,2	70,3	44,3	62
2	51,3	101,7	50,6	84,7	51,5	72,7	47,1	59,2
3	49,9	101,7	49,1	85,5	56,8	72,6	48,5	60,7
4	50,9	101,6	48,8	85,5	54,9	69,7	48,5	59
5	51,7	101,6	54,5	85,6	58,6	68,3	48,6	62,8
6	49,2	102	43	85,5	53,4	69,2	42,8	62
7	50,9	101,5	49,7	86,7	55,8	71,4	48,5	59,2
8	51,3	102,1	47,7	86,1	53,6	67,8	48,8	59,7
9	49,5	101,8	40,9	86,3	57,1	66,3	43	59,8
10	49,4	101,7	40,5	86,8	55,4	65,6	44	59,1
11	49,6	102,1	41	86,6	57	68,2	43	57,4
12	49,4	101,9	43	87,8	52,7	70,4	42,3	58,1
13	50,1	102,2	42,2	86,9	55,4	65,1	50	59,3
14	53	102,1	44,4	85,2	55,5	68,3	48,9	55,7
15	50,1	102,1	41,5	86,2	53,8	68,2	42,6	59
16	49,8	101,8	46,7	85,8	53,1	65,2	41,5	60,1
17	49,6	102,1	47,1	86,8	54,9	64,8	43,1	60,1
18	50	101,9	46,5	84,8	56,7	69,9	41,2	60,4
19	50	102	42,3	85,3	62,6	67,3	41,8	59,8
20	49,9	102	44,8	86,4	59,8	66,2	44	60,1
21	49,6	101,7	43,5	86,7	57,9	66,9	42,2	59,8
22	49,6	101,9	42,8	86,9	56,7	67,5	41,4	60,78
23	18.Şub	101,8	48	86,4	54,1	66,4	42,3	59,7
24	49,7	101,7	41,4	86,1	48	64,6	42	58
25	49,6	101,9	42,7	87,5	56,4	65,2	42	58,8
26	50,1	101,7	42,2	86,6	52,3	63,9	41,1	57,8
27	50	102,1	43,1	87,4	51,7	65,2	41,4	60,1
28	49,7	102	41,7	86,6	52,1	68,5	40,5	58,6
29	49,6	101,8	42,9	86,3	54,6	66,5	41,8	60,1
30	51,7	101,9	52,1	85,5	57,9	67,3	42,3	58
31	50,1	101,7	47,8	86,2	51,1	68,2	42,6	59,9
32	50,4	101,9	55,4	85,2	60,5	71,6	41,8	61,2
33	49,8	101,7	46,5	85,5	58,3	69,3	43,6	61,3

	Stand Type: Leafy, 1-2							
	0_m		10_m		25_m		50_m	
Number of Measurement	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**
1	45,5	82,3	50,7	101,5	44	64,2	40,4	55,4
2	51,65	83,2	51,6	101,9	49,2	63,4	45,4	57,8
3	43,5	82,3	51,5	101,6	52,1	64,7	42,4	52,7
4	41,5	80,1	51,5	102	45,9	61,3	41,8	50,3
5	42,9	79,7	51,5	102,2	43,7	58,7	41,2	52,1
6	43,4	79,2	51,8	102	46,5	55,2	40,4	47,4
7	44,6	78,4	51,7	102,3	44,6	55,3	41,7	49,8
8	40,4	80,2	49	101,2	43,5	66,9	43,1	58
9	40,3	78,5	51,1	101,2	43,2	65,8	39	60,1
10	42,5	78,4	51,1	101,6	44,8	64	43,3	59,3
11	47,8	88,7	51,9	102	42,3	69,4	46,9	61,1
12	45,9	88	51,9	102,1	41,4	76,9	42	70,5
13	44,7	88	51,8	102,2	43,5	77,7	43,9	70
14	42,4	92,8	51,9	101,9	42,6	81,6	41,5	70,5
15	41,5	88,7	51,8	102,3	44,5	75,6	43,2	66,1
16	43	87,8	51,3	102,2	44,6	74,5	42,5	71,5
17	43,5	87,5	51,6	102,3	45,8	75,1	49,4	65,7
18	42,7	86,7	51,8	102,5	48,6	71,9	40	57,1
19	44,2	84,7	51,7	102,4	43,4	72,4	42,6	59,4
20	43,7	83,1	51,8	102,5	44,8	75,2	44	68,3
21	42,8	83,2	50,3	102,4	41,4	75,4	44,1	51,2
22	41,6	86,9	49,6	102,4	42,3	69,9	41,8	58,8
23	42,6	85	49,5	102,1	43,1	66,9	42,1	57,2
24	41,9	85,2	51,2	102	44,8	73,2	39,1	56,1
25	41,7	84,7	49,7	102	42,9	71,8	41	54,9
26	41,8	84,2	50,1	102,2	43,8	69,1	42,9	58,6
27	41,8	85,5	49,7	102,1	44,2	68,1	40,3	61,9
28	44,5	86	49,9	102	42,8	69,5	41,7	61,3
29	41,9	84,6	49,8	102,1	40,8	72,5	40,7	67,6
30	41,5	82,4	50,1	102	39,6	70,8	39,7	54,6
31	41,3	83	50	101,5	44,7	70,7	41	46,1
32	42,9	81,4	49,8	101	42,1	69	38,1	45,4
33	43,3	81,8	50,6	102,2	50,6	71,7	42,4	49,6

	Stand Type: Leafy, ab, 1-2							
	0_m		10_m		25_m		50_m	
Number of Measurement	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**
1	45,5	82,3	50,7	101,5	44	64,2	40,4	55,4
2	51,65	83,2	51,6	101,9	49,2	63,4	45,4	57,8
3	43,5	82,3	51,5	101,6	52,1	64,7	42,4	52,7
4	41,5	80,1	51,5	102	45,9	61,3	41,8	50,3

Attachment 2 (Continued)

5	42,9	79,7	51,5	102,2	43,7	58,7	41,2	52,1
6	43,4	79,2	51,8	102	46,5	55,2	40,4	47,4
7	44,6	78,4	51,7	102,3	44,6	55,3	41,7	49,8
8	40,4	80,2	49	101,2	43,5	66,9	43,1	58
9	40,3	78,5	51,1	101,2	43,2	65,8	39	60,1
10	42,5	78,4	51,1	101,6	44,8	64	43,3	59,3
11	47,8	88,7	51,9	102	42,3	69,4	46,9	61,1
12	45,9	88	51,9	102,1	41,4	76,9	42	70,5
13	44,7	88	51,8	102,2	43,5	77,7	43,9	70
14	42,4	92,8	51,9	101,9	42,6	81,6	41,5	70,5
15	41,5	88,7	51,8	102,3	44,5	75,6	43,2	66,1
16	43	87,8	51,3	102,2	44,6	74,5	42,5	71,5
17	43,5	87,5	51,6	102,3	45,8	75,1	49,4	65,7
18	42,7	86,7	51,8	102,5	48,6	71,9	40	57,1
19	44,2	84,7	51,7	102,4	43,4	72,4	42,6	59,4
20	43,7	83,1	51,8	102,5	44,8	75,2	44	68,3
21	42,8	83,2	50,3	102,4	41,4	75,4	44,1	51,2
22	41,6	86,9	49,6	102,4	42,3	69,9	41,8	58,8
23	42,6	85	49,5	102,1	43,1	66,9	42,1	57,2
24	41,9	85,2	51,2	102	44,8	73,2	39,1	56,1
25	41,7	84,7	49,7	102	42,9	71,8	41	54,9
26	41,8	84,2	50,1	102,2	43,8	69,1	42,9	58,6
27	41,8	85,5	49,7	102,1	44,2	68,1	40,3	61,9
28	44,5	86	49,9	102	42,8	69,5	41,7	61,3
29	41,9	84,6	49,8	102,1	40,8	72,5	40,7	67,6
30	41,5	82,4	50,1	102	39,6	70,8	39,7	54,6
31	41,3	83	50	101,5	44,7	70,7	41	46,1
32	42,9	81,4	49,8	101	42,1	69	38,1	45,4
33	43,3	81,8	50,6	102,2	50,6	71,7	42,4	49,6

	Stand Type: Coniferous, c-d, 3-4							
	0_m		**10_m**		**25_m**		**50_m**	
Number of Measurement	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**
1	49,5	102,1	40,8	91,7	53,3	82,4	41,3	73
2	49,8	102	46,9	91,2	56,1	80,6	43,2	75,8
3	49,9	102,1	45,3	90,1	56,5	79,7	43	73,6
4	49,8	101,9	43,1	88,4	55,5	81,2	42,2	72,7
5	49,6	101,9	42,9	91,2	59,8	81,7	41,6	74,1
6	49,8	102,1	42,7	91,3	57,4	82,4	41,7	73,9
7	49,9	101,9	43,7	90,4	53,2	82,4	41,8	72,6
8	49,9	102	44,4	89,7	53,9	79,9	41,4	74,3
9	49,8	102	41,4	91,3	55,2	80,8	41,1	71,7

Attachment 2 (Continued)

10	49,8	101,9	41,2	91,3	49,4	81,5	40,7	73,7
11	49,7	102	41,8	91,7	55,6	75,6	42,2	70,4
12	49,8	102,1	42,1	90,4	52,3	74,7	41,3	75,9
13	49,9	102	41,7	91,8	46,5	79,4	42,7	77,4
14	50,1	101,9	41,3	89,7	49,6	80,3	42	71,1
15	50	102,1	47	93,1	47,8	71,7	41,3	71,4
16	49,7	102,1	46,3	88	51,8	75,7	41,1	67,8
17	51,2	101,9	42,2	92,4	53,8	75,2	40,6	64,3
18	50,1	102	42,4	88,8	62,1	73,6	40,8	62
19	51	102	42,1	88,5	50,2	72,9	40,2	62,3
20	51,5	102,1	41,8	90	47,2	73,9	40,6	60,7
21	50,2	101,9	40,7	90,8	44,8	77,7	40,2	65
22	51,8	101,7	42,9	91,1	47,7	75,1	40,6	69,5
23	51,6	102,2	42,7	90,8	46,6	75,2	40,6	74,1
24	47,3	102,3	44	91	48,1	72,9	41,1	72,8
25	46,4	102,3	42,3	88,3	47,4	73,3	40,4	69,2
26	46,5	102,2	41	87,5	42,7	67,8	41,2	65,9
27	47,6	101,8	49,5	83,9	49,1	69,2	42,5	65,8
28	50	102	42,1	81,9	46,8	71,5	42	68,9
29	50,7	102	42,3	80,7	48,9	73,7	41,4	66,3
30	51,4	101,9	50	81,5	48,7	72,6	42,2	67,8
31	51,5	101,6	41,9	81,6	52,7	70,6	44,1	65,9
32	51,7	101,9	42,8	78,2	51,2	72,3	43,7	69,4

	Stand Type: Coniferous, a-b, 1-2							
	0_m		**10_m**		**25_m**		**50_m**	
Number of Measurement	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**
1	71,6	102,5	44,4	80,3	52,4	67,6	50,3	58,3
2	49,6	102,6	50,1	81,5	52,1	67,3	52,1	60
3	59,2	103,1	50	80,9	51,4	61,8	53,4	56,7
4	57	102,6	57,3	86,2	48,1	68,1	49,7	60,3
5	58,8	102,3	48,9	86,8	46,3	67,9	52,9	58
6	54,8	102,6	50,6	86,9	45,9	66,3	46,9	55,2
7	52,7	102,8	52	85	45,6	67	51,3	56,6
8	53	102,7	52,6	85,2	48,2	68,5	53,7	56,8
9	54	102,7	51,5	84	49,3	67,9	49,7	55,7
10	50,3	102,4	52,1	78	46,2	64,6	48,1	56
11	53,7	102,3	51,9	81,8	46,7	66,3	49,9	58,5
12	58,8	102,1	61	79,9	46,2	66,2	50,1	57,4
13	61,6	101,9	58,9	75	44,9	64	50,7	55
14	50,4	102,6	69,9	77,2	47,1	64,5	50,3	55,5
15	48,6	101,9	52,7	78	42,4	63,5	49,7	54,1

Attachment 2 (Continued)

16	47,3	102,2	50,4	77,3	48,5	61,1	46,1	53,2
17	46	101,9	53,3	76,9	43,3	62,2	50,1	55,9
18	46,7	102	57,1	78	44,8	61	49,5	53,9
19	47,1	101,8	56,6	77	41,3	63,8	49,7	54,3
20	45,1	101,8	58,7	76,3	45,3	60,3	50,2	54,9
21	48,9	100,8	51,9	73,7	53,8	67,2	44	55,5
22	47	100,1	52,9	74,4	55,9	66,7	41,7	58,1
23	45,1	100,9	55,4	74,6	54,1	61,8	43,9	54,7
24	42,4	100,8	58,2	73	51,8	67,9	41,9	52,8
25	42,6	100,5	53,8	73,5	64,2	67,3	43	53,1
26	48,2	100,5	64	75	58,2	60,5	52,1	54,1
27	44,3	100,4	55,4	73,9	56,9	64,6	42,7	55,6
28	46	100,5	64,5	75,4	54,3	65,9	44,1	50,8
29	42,2	100,5	61,8	74,1	58,2	59,4	42,9	50,4
30	43,2	100,4	67,1	75,9	61,4	64,8	43,7	48,4

	Stand Type: Leafy, a-b, 3-4							
	0_m		**10_m**		**25_m**		**50_m**	
Number of Measurement	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**
1	51,5	101,8	41,8	81,1	41,7	69,3	40,7	52,5
2	51,6	102	43,9	82,2	42,2	69,8	41,6	52,6
3	51,8	101,9	41,7	83,7	43,2	67	43,7	52,9
4	49,8	101,1	43,5	83,9	42,6	68,6	42,1	54,9
5	52,1	101,2	42,2	83,4	40,5	67,6	36,7	54,7
6	52,2	101,2	44,1	79,6	43,4	67,2	37,3	53
7	52,5	101,3	44,8	80,3	44,2	67,1	38,6	53,1
8	52,4	101,1	42,8	79,7	43,9	68,9	39,7	53,3
9	52,2	101,4	44,3	75,9	45,8	64,2	38,1	51,1
10	52,3	101	42,5	76,9	47,8	63,3	38,9	50,9
11	51,4	100,7	42,8	78	46,5	63,3	41,2	50,6
12	51,5	100,8	44,1	77,4	49,3	65,1	41,6	49,9
13	50,5	100,8	43	77,1	47,3	66,3	45,5	51,5
14	51,3	100,8	42,2	75,6	47,1	63,3	42,5	48
15	51,2	100,9	41,8	74,6	43,1	65,8	41,6	47,6
16	50,3	101	42	75,2	44,4	67,8	38,8	47,3
17	50,3	101,1	43,2	74,5	49,8	66,9	44,2	57,1
18	51,4	100,9	42,8	75,2	46,2	66,6	41	49,4
19	51,1	100,9	42,2	75,1	48,5	61,4	39,1	49,2
20	51,6	100,9	42,9	76,1	47,9	64,8	42,6	50,1
21	51,7	101	43,7	76,6	45,7	62,3	40,4	49,2
22	51,6	101,1	41,4	75,1	42,5	63,5	44,2	52,6
23	51,6	100,9	42,9	76,8	45,2	65,9	44,6	51

Attachment 2 (Continued)

24	52,4	101,1	43,8	75,7	53,2	62,4	42,8	51,4
25	51,9	101,2	44,1	74,2	50,5	60,6	41,7	51,6
26	51,7	101	44,6	74,6	50,2	62,6	43,2	54,5
27	51,6	101,3	41,9	76,5	44,8	62,1	41,7	51,7
28	51,9	101	44,5	77	48,4	59,8	39,3	55,6
29	51,6	100,9	42	76,4	45	61,1	38,8	49,8
30	51,8	101,3	43,5	78,1	43,8	60,1	37,8	51,2
31	51,6	101,3	42,2	74,9	42,7	66,6	40,4	53,8
32	51,6	101,2	43,9	74,8	48,4	61,4	41,7	54,8
33	51,6	101,2	43,6	76,5	47,3	62,1	42,3	50,8

	Stand Type: Leafy, cd, 3-4							
	0_m		**10_m**		**25_m**		**50_m**	
Number of Measurement	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**
1	49,5	101,7	51,1	88,9	57,6	74,9	42,5	67,7
2	49,6	101,7	42,1	90,3	48,2	73,9	42,1	67,4
3	44,3	101,5	41,3	89,7	53,5	77,2	41,4	63,7
4	44,7	101,5	48	89	51,8	75,6	40,8	69,1
5	49,8	101,3	44,3	90,2	53,1	74,4	43,6	67,7
6	48,6	101	42,6	89,2	53,9	75,5	42,1	63,7
7	48,8	101,3	43,3	88	55,9	74,9	42,4	63,3
8	48,6	101,3	46,5	88,3	50,6	72,1	40,3	66,6
9	48,5	101,3	42,4	88,2	57,5	73,7	40,8	64,1
10	49,1	101,4	44,3	87,8	49,9	68,2	41	66,9
11	49,3	101,2	42	87,2	56,8	67,7	39,5	65,9
12	49,2	101,9	44	87,1	52,7	68,2	42,4	62,5
13	49,4	101,7	45,3	86,6	48,9	68,4	41	65,2
14	49,3	102	42,3	86,2	52,2	68,9	40,5	65,4
15	49,2	101,7	43,5	85,5	53,8	69,2	39,4	62,4
16	49,2	101,6	42	82,7	54,6	71,1	39,6	65,4
17	49,2	101,7	42,3	80,8	51,8	69,3	39,6	64,8
18	49,3	101,8	44,6	81,9	53,2	67,4	40	63,3
19	49,2	101,7	42,4	80,7	48,6	66,8	39,2	64
20	49,3	101,7	40,9	76,7	50,9	67,6	39,5	62,1
21	49,6	101,9	41,2	79,1	46,4	66,7	39,1	62,5
22	49,6	102	43,6	76,4	47,9	65,3	42,1	61,3
23	49,5	102,1	42,5	76,5	45,8	69,1	42,3	62,3
24	49,3	101,9	50,4	76,4	50,7	65,2	39,5	61,1
25	49,4	101,8	41	74	46,5	64,2	39,7	62,5
26	49,3	101,8	40,8	77,2	45,8	66,6	39,3	62,8
27	49,3	101,9	40,4	77,7	51,8	64,2	39	60,6
28	49,5	101,7	41,1	78,1	50,9	65,1	39,1	62

Attachment 2 (Continued)

29	49,5	101,8	44,1	75,3	49,1	66,8	40,4	64,2
30	49,7	101,7	49,2	76,6	49,2	64,6	39,8	63,4
31	49,5	101,7	45,9	73,3	51,4	71,2	39,1	62,7
32	49,7	101,4	45	72,8	48,9	66,8	39	64,8
33	49,7	101,7	44,9	74,5	51	69,8	39,5	65,1

	Stand Type: Coniferous, c-d, 1-2							
	0_m		**10_m**		**25_m**		**50_m**	
Number of Measurement	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**
1	49,8	102	43,9	84,7	58,7	70,7	43,7	62,4
2	46,3	101,9	43,7	87,5	53,3	71,8	43,1	63,8
3	49,5	102	43,1	87,2	53,9	71,4	44	61,9
4	49,6	101,7	44,3	87	50,8	69,3	43,3	64
5	49,5	101,8	52,3	86,2	58,3	67,4	43,2	60,9
6	49,9	101,8	50,5	87,9	59,4	67,3	43,6	62,2
7	49,8	101,8	47,4	85	59,3	69,1	43,3	61,8
8	49,6	101,6	46,1	87,4	53,8	66,4	43,4	60,8
9	50	102,1	45,6	86,9	51,6	67,7	42,7	60,4
10	49,7	102	54,8	85,8	55,3	64,7	43,5	60,2
11	49,8	102	52,1	86,6	49,5	64,7	44	58,5
12	49,9	101,8	47,6	84,9	49,6	66,3	48,5	60,5
13	49,8	101,9	46,6	84,5	50,1	65,8	46,5	59,7
14	49,9	101,9	49,6	84,3	54,3	71,1	47,4	60,4
15	50,2	102	52,6	83,4	53,4	63,7	49,7	58,7
16	50,3	102	48	83,6	56,6	65,4	48	59,6
17	50,2	102,1	53,7	83,3	57,5	65,3	45,3	57
18	50,3	101,5	47,6	86,3	54,8	66,4	47,3	57,8
19	49,9	101,5	51,1	83,8	51,6	63,4	47	57,5
20	19.Şub	101,7	46,2	83,9	53,6	66,6	45,1	57,1
21	49,9	101,8	46,6	84	58,1	70,2	46,6	56,7
22	49,8	101,8	48,2	84,6	54,4	65,1	44,2	58,7
23	49,6	101,9	47,9	84,6	53,8	70,4	43,9	59,4
24	49,8	101,9	44,9	84,8	56,2	72	43	59,3
25	49,8	101,9	53,8	84,6	66	66,7	45,4	57,4
26	49,8	101,9	46,2	82,1	58,9	63,8	48,4	58,9
27	50,3	101,9	53,9	81,9	54,3	66,3	45,2	58,7
28	50,2	101,8	46,3	85	56,1	69,8	45,7	58,1
29	50,1	101,8	47,5	84,8	55,5	67,3	45,3	58,1
30	50,2	101,7	51,1	84,5	53,3	64,5	45,3	63,7
31	51,4	101,7	54,1	83,3	57,6	62,2	48,2	59,3
32	51	101,7	53,8	82,7	57,4	63,5	46,7	58,5

Attachment 2 (Continued)

33	50,3	101,8	55,5	82	54,4	65,3	44,9	58,1

	Stand Type: Coniferous, c-d, 1-2							
	0_m		**10_m**		**25_m**		**50_m**	
Number of Measurement	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**	**Silent**	**Noisy**
1	49,8	102	43,9	84,7	58,7	70,7	43,7	62,4
2	46,3	101,9	43,7	87,5	53,3	71,8	43,1	63,8
3	49,5	102	43,1	87,2	53,9	71,4	44	61,9
4	49,6	101,7	44,3	87	50,8	69,3	43,3	64
5	49,5	101,8	52,3	86,2	58,3	67,4	43,2	60,9
6	49,9	101,8	50,5	87,9	59,4	67,3	43,6	62,2
7	49,8	101,8	47,4	85	59,3	69,1	43,3	61,8
8	49,6	101,6	46,1	87,4	53,8	66,4	43,4	60,8
9	50	102,1	45,6	86,9	51,6	67,7	42,7	60,4
10	49,7	102	54,8	85,8	55,3	64,7	43,5	60,2
11	49,8	102	52,1	86,6	49,5	64,7	44	58,5
12	49,9	101,8	47,6	84,9	49,6	66,3	48,5	60,5
13	49,8	101,9	46,6	84,5	50,1	65,8	46,5	59,7
14	49,9	101,9	49,6	84,3	54,3	71,1	47,4	60,4
15	50,2	102	52,6	83,4	53,4	63,7	49,7	58,7
16	50,3	102	48	83,6	56,6	65,4	48	59,6
17	50,2	102,1	53,7	83,3	57,5	65,3	45,3	57
18	50,3	101,5	47,6	86,3	54,8	66,4	47,3	57,8
19	49,9	101,5	51,1	83,8	51,6	63,4	47	57,5
20	19.Şub	101,7	46,2	83,9	53,6	66,6	45,1	57,1
21	49,9	101,8	46,6	84	58,1	70,2	46,6	56,7
22	49,8	101,8	48,2	84,6	54,4	65,1	44,2	58,7
23	49,6	101,9	47,9	84,6	53,8	70,4	43,9	59,4
24	49,8	101,9	44,9	84,8	56,2	72	43	59,3
25	49,8	101,9	53,8	84,6	66	66,7	45,4	57,4
26	49,8	101,9	46,2	82,1	58,9	63,8	48,4	58,9
27	50,3	101,9	53,9	81,9	54,3	66,3	45,2	58,7
28	50,2	101,8	46,3	85	56,1	69,8	45,7	58,1
29	50,1	101,8	47,5	84,8	55,5	67,3	45,3	58,1
30	50,2	101,7	51,1	84,5	53,3	64,5	45,3	63,7
31	51,4	101,7	54,1	83,3	57,6	62,2	48,2	59,3
32	51	101,7	53,8	82,7	57,4	63,5	46,7	58,5
33	50,3	101,8	55,5	82	54,4	65,3	44,9	58,1

CV

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Professional Experience

1) The high institute for Mechanical and Electrical Trades in Zuwara (1996) As a Collaborator.
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3) The high institute for Mechanical and Electrical Trades in Zuwara (2003) As a university staff member .
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Science Publishing

Elfantazi, M.F.M., Aricak, B. & Baba, F.A.M. (2018). Changes in Concentration of Some Heavy Metals in Leaves And Branches of Acer Pseudoplatanus Due to Traffic Density. *International Journal of Trend in Research and Development,5*(2): 704-707.

Elfantazi, M.F.M., Aricak, B., Ozer Genc, C. (2018). Concentrations In *Morus Alba L*. Leaves and Branches Due To Traffic Density. *International Journal of Current Research. 10*(05): 68904-68907.