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Measuring PM level in summer season and preparing dispersion modelling for Hacikaymak Region in Selcuklu, Konya, Türkiye

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Abstract

Global rapid urbanization, the emergence of industry growth and the resulting increased energy demand, the deterioration of air quality in urban and surrounding cities, and ambient air pollution are faced with serious health problems. Different emissions from fossil fuels used in energy production in different environments and processes are emitted to the environment. Some of these emissions are toxic and have acute toxicity, some of them can accumulate in the body and cause chronic effects, and some have a physical mechanism of negative action. In addition to their physical effects of emissions called as particulate matter can affect some of the toxic substances, they carry itself or absorb from the environment they are carrying them to reach to thinnest parts of the lungs. While only 10 micron and below PM values were measured in the previous periods, the measurement importance of PM below 2.5 micrometres has emerged in recent years due to its importance. It is thought that $PM_{2.5}$ is mostly caused by combustion products or exhaust gases of traffic vehicles. At significant levels, prolonged contact with polluted air encounters various human health problems. Specifically, it is a major driver of the rapid development of urban facilities and services to respond to the daily work and life patterns of middle- and high-income residents in the centre of modern metropolises. Therefore, it is necessary to establish air quality control strategies and identify aerosol sources. In this study, distribution modelling was made by measuring PM values in summer month in Hacıkaymak neighbourhood located in Konya city centre (Turkey).

Introduction

It is known that most environmental pollutants are emitted through large-scale human activities such as industrial machinery, power generation stations, combustion engines and traffic vehicles. Because these activities are carried out on a very large scale, it is estimated that vehicles are responsible for about 80% of today's air pollution [1]. Several other human activities such as plant growing techniques, gas stations, fuel tank heaters and cleaning procedures, as well as various natural resources such as volcanic eruptions and forest fires, also affect our environment [2]. Major sources include emissions of pollutants from power plants, refineries and petrochemical, chemical and fertilizer industries, metallurgy and other industrial plants, and finally municipal combustion plants. Indoor resources include household cleaning activities, dry cleaners, printing houses and gas stations. Mobile resources include cars, vehicles, railroads, airlines, and other types of vehicles. Finally, natural resources include physical disasters such as forest fire, volcanic erosion, dust storms and agricultural burning, as previously noted [3].

In many developing countries, the problem becomes more serious due to rapid industrialization, overpopulation, and irregular urbanization [4]. Negative air quality occurs especially in countries with social inequality and a lack of knowledge in the sustainable management of the environment. The use of wood or poor-quality fossil fuels for domestic needs exposes people to poor quality and polluted air indoors. It is important that more than three billion people worldwide use poor quality energy sources for their daily heating and other domestic energy needs [5].

Human activities have many negative effects on the environment by polluting the atmospheric air and therefore water resources and soil. Although it was of great importance in terms of providing services for the society with industrialization, it also brought with it the production of huge amounts of pollutants that spread into the atmosphere and are harmful to human health. Global environmental pollution is also recognized as a multifaceted international public health problem. Social, economic and lifestyles are associated with this major environmental pollution problem. Industrialization and urbanization are reaching sad dimensions in the world today. Human-induced air pollution is considered one of the biggest public health hazards in the world, given that it causes about 10 million deaths annually [6].

Long-term effects associated with air pollution are cardiovascular disease, heart failure, chronic asthma, and mortality. In a Swedish study, diabetes is triggered after long-term exposure to air pollution [7]. Moreover, air pollution appears to have various adverse health effects on human life, such as respiratory, cardiovascular, mental disorders [8], and cause adult and infant mortality or chronic diseases [6].

Air pollution is mainly effective in large urban areas, where road emissions contribute the most to the deterioration of air quality. There is also the danger of industrial accidents where toxic fog emission can be fatal to surrounding people. The distribution of pollutants is determined by many parameters, especially atmospheric stability, and wind [6]. The accumulation of air pollution, particularly sulphur dioxide and smog, reached 1,500 mg/m3, resulting in an increase in the number of deaths in London in December 1952 (4,000 deaths) and New York City in 1963 (400 deaths) [9]. Based on monitoring of outdoor pollution in many metropolitan cities of the USA, a relationship between pollution and mortality has been reported [10].

In this study, it is aimed to prepare the spatial distribution modelling in the city centre by making measurements of PM_{10} and $PM_{2.5}$ in summer. It is aimed to prepare a PM pollution map with the data obtained from the modelling and to make comments on emission skies.

Material and Method

The variation of air pollutant concentrations in cities between regions has been observed. This variation depends on the characteristics of the regions. This study was initiated for the measurement of emission inventory based on open air areas in the Hacıkaymak region of Selcuklu district of Konya city. The circumference of this chosen region is 6301 m, and its area is 2.25 km^2 (Fig. 1). Thirteen different locations were selected for measurement points. These locations were chosen with due consideration to the spread and sources of existing air pollution. It was decided that the most suitable regions for data analysis.

The measurement methods of dust and particles in the air vary according to the volume of the particles and the desired results in the study. The "particle counter PCE-PCO1" is a laser particle counter and dust measuring device configured to determine the concentration of airborne particles by means of electronic recording.

Measurements were made in August month in summer season. During this month, particulate matter measurement data were collected by making weekday and weekend measurements, daily measurements, day and night measurements and hourly measurements (08:00, 12:00, 15:00, 18:00, 22:00 in each day).

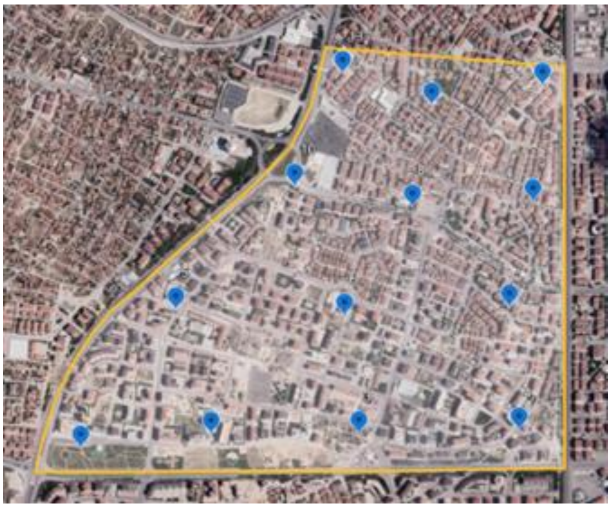

Figure 1. Hacıkaymak region Konya, Selcuk district and determined study area measurement points

Surfer 19 software, produced by Golden software company, consists of a 3D graphics system. It is used for gridding scattered data recorded in different environments, creating contour maps and obtaining 3D images. Articles prepared in accordance with the principles of writing and approved by the review board are published.

After taking the coordinates of the measurement points, the data collected at the end of each season were listed in the Excel program as daily, weekly and hourly averages. In addition to the X and Y coordinates, the Z coordinate also represents the measured $PM_{2.5}$ or PM_{10}. A worksheet was created by transferring the XYZ coordinates to the Surfer-16 program.

Results

This study aimed at measuring particulate matter, evaluating air quality and reducing air pollution in Konya, Selcuklu region. The measurement of PM_{10} and $PM_{2.5}$ values in this region was made and the degree of pollution was evaluated by modelling it with the Surfer-19 modelling program. Based on these values, it is aimed to contribute to reducing these values to the lowest levels by determining the regions where PM_{10} and $PM_{2.5}$ pollution are intense and their sources, the factors causing pollution. As a result of research, measurements, and analyses, it was concluded that there are many factors affecting PM_{10} and $PM_{2.5}$ pollution. Considering seasonal and months, PM_{10} and $PM_{2.5}$ pollutant values were determined to be lower in summer months.

PM_{10} and $PM_{2.5}$ pollutant values considering the days of the week; were found to be lower on weekdays and higher on weekends. The traffic density on the weekend is higher than during the week. For this reason, the measured values are higher at weekends and lower during weekdays.

PM_{10} and $PM_{2.5}$ pollutant values considering hours; At certain times of the day, the measurement results were above the average. These hours are the starting and ending hours. Due to heavy traffic, the measurements we made at 08:00 and 18:00 were very high. Average values of seasonal measurements were found as $PM_{2.5}$ value 749 μg/m^3 and PM_{10} value 31 μg/m^3 in August (Table 1).

Table 1. $PM_{2,5}$ and PM_{10} weekly average measurement values

Seasonal Average Measurement Values	$PM_{2,5}$	PM_{10}
Average of Measurement Values for August	749	31

Discussion

PM_{10} and $PM_{2.5}$ pollutant values considering seasonal and months; It was determined that the weather was higher in the winter months and lower in the summer months. When we investigate the reason for this, it is primarily the pollution that occurs due to the fuels burned for heating purposes. In addition, due to the low air temperature values, people prefer to use public transport, walk, or bike, etc. The use of special vehicles instead of using them also increases the pollutant values. In EU countries and Turkey, the limit value of PM_{10} (Particulate Matter) has been determined as 50 μg/m^3 as a result of 24-hour measurement. As a result of the annual measurement, the limit value has been determined as 40 μg/m3.

Considering the weather conditions, PM_{10} and $PM_{2.5}$ pollutant values; It was determined that it was lower in rainy weather and higher in windy weather. When the weather is rainy, some of the particulate matter in the air goes down with the precipitation and the measurement values are lower. The opposite happens in windy weather. It was observed that particulate matter increased in conditions such as wind, breeze, and storm.

Conclusion

It was determined that PM_{10} and $PM_{2.5}$ 0 concentration were not as important as the relationship with wind speed as it was with precipitation. Despite this, it was observed that $PM_{2.5-10}$ concentration was positively correlated with wind speed in summer. In another study conducted during the summer season, it was noted that there was a positive correlation between coarse particles and wind speed. As a solution proposal because of research and analysis; Attention should be paid to the fuels used during industrial activities and the flue filters in the facilities. To reduce the exhaust and gases from motor vehicles, we can ensure less pollution by using public transportation, at least in an environmentally friendly way such as cycling or walking.

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