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Seasonal Determination of Particulate Matter (PM) Pollution in Harran University Osmanbey Campus

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Abstract **–** Inhalable particulate matter ($PM_{2.5}$ and PM_{10}) pollution is a significant environmental and public health issue globally. Exposure to high levels of PM, especially fine particles, can have severe health consequences. These particles can come from a variety of sources, including natural events like dust storms and wildfires, as well as human activities such as industrial processes and transportation. In order to determine $PM_{2.5}$ and PM_{10} levels at Şanlıurfa Harran University Osmanbey Campus, samples were taken at certain times of the day using the Termo Scientific pDR 1500 personal DataRam sampler device in the autumn and spring seasons. In order to determine spatial difference, 40 different points were determined within the campus. The highest value for $PM_{2.5}$ in November 2019 was measured at Point 5 with 39.46 µg/m^3. The highest value for PM_{10} was measured at Point 5 with 70.08 µg/m^3. The highest value for $PM_{2.5}$ in April 2020 was measured at Point 1 with 46.79 µg/m^3. The highest value for PM_{10} was measured at Point 5 with 78.38 µg/m^3. Considering the spatial distribution seven points (1, 5, 10, 14, 15, 16, and 32) with the highest $PM_{2.5}$ and PM_{10} pollution were determined among 40 different points determined for both periods. Common reasons for this include the fact that these points are exposed to heavy vehicle use, the months in which the study was carried out are seasonal transition months, and dust transport is at its highest levels in these months, which supports the results. Moreover, low pollution levels were determined at the points where there is almost no vehicle use and are far from the campus center.

Keywords – Air Pollution, Outdoor Air Quality, $PM_{2.5}$, PM_{10}, Osmanbey Campus

I. Introduction

Air pollution is a public health and environmental issue that affects human health. The main pollutants in the air are carbon monoxide, nitrogen oxide, ozone, sulfur dioxide and inhalable particulate matters (PMs). Among air pollutants PMs in particular are one of the most common air problems in arid and semi-arid regions, with known negative health effects on human health and the ecological environment. Characterization of atmospheric aerosols called particulate matter poses a great challenge because they vary in spatial and temporal scales. Inhalable sized PMs are called $PM_{2.5}$ and PM_{10} according to their sizes according to the US Environmental Protection Agency (EPA). Particles with a size of PM ≤ 2.5 µm are classified as fine particulate matter, and PM≤ 10 µm are classified as coarse particulate matter [1]. Figure 1, gives information about the size of PMs.

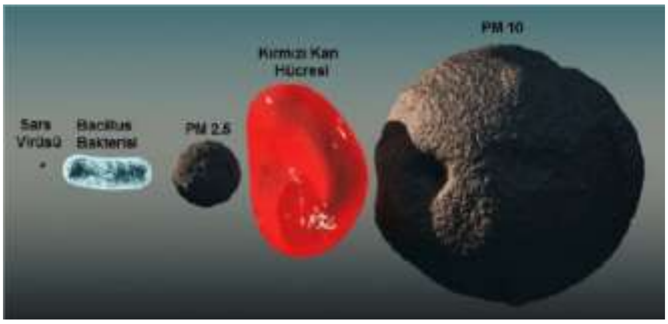

Figure 1. Size comparison of PM with virus, bacteria and blood cell [2]

The Southeastern Anatolia region which is the driest region of Turkiye and located on the air flow route of the Syrian, Sahara and Arabian peninsula deserts is significantly exposed to PMs pollution due to intense dust waves [3]. Since air pollution events occurring in a country can affect not only that country but also the countries in the air flow route, PMs are one of the most complex problems in terms of air quality and climate change policies. A total of 1.5x109 tons/year of dust originating from arid and desert regions mixes with the atmosphere, and it is known that 50% of this rate belongs to the Sahara desert [4], [5], [6], [7].

Air pollution is a fundamental problem that can negatively affect human health and comfort, various ecosystems, meteorological activities that are effective in climatic events, and various structures (buildings, vehicles, engines, etc.) and can cause health problems in the long term unless precautions are taken. $PM_{2.5}$ which contributes greatly to air pollution has been shown by many studies that long-term exposure results in heart disease, stroke, respiratory diseases and lung cancer. It has been determined that air pollution has an impact on the deaths of 3.2 million people worldwide and is the 6th risk factor [8], [9].

Studies conducted in 2015 stated that air pollution was responsible for 19% of all cardiovascular deaths, 24% of deaths due to heart disease, 21% of deaths due to stroke and 23% of deaths due to lung cancer [10]. PM size and chemical structure are thought to be critical factors affecting its effects on human health and the quality of the atmospheric environment. The $PM_{2.5}/PM_{10}$ ratio is very important in terms of its effect on the respiratory system. $PM_{2.5}$ has a more specific surface area than PM_{10} and can remain suspended in the air longer and be transported more easily than PM_{10}. It also has the capacity to collect harmful substances due to its surface area. PMs enter the human body through breathing and can generally cause negative effects in various tissues in the body especially in the respiratory tract [11].

Figure 2 shows that PMs can be transported in the human body.

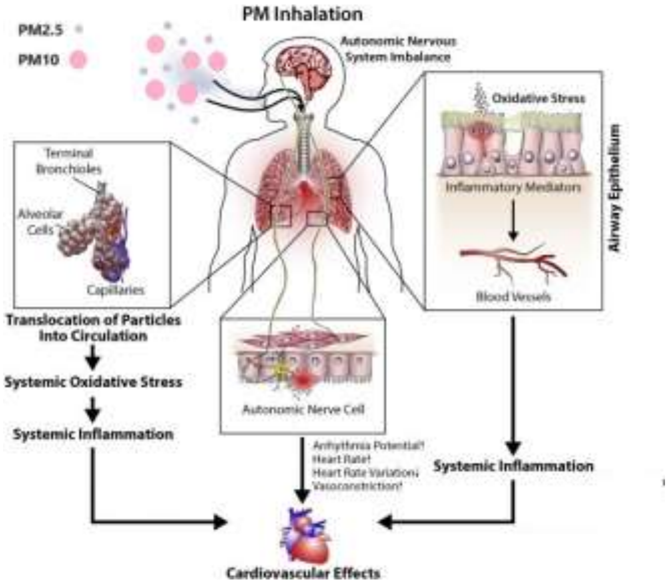

Figure 2. Illustration of the systemic effects diagram of inhalation PM exposure [12]

In order to greatly reduce the negative effects of air pollution on health it has been recommended that World Health Organization (WHO) air quality standards (25 $\mu g/m^3$ and 50 $\mu g/m^3$ for $PM_{2.5}$ and PM_{10}, respectively) be met worldwide [13]. In Turkiye, in the Air Quality Management Regulation that came into force on June 6, 2008 PM_{10} standards were determined as 50 $\mu g/m^3$ and 40 $\mu g/m^3$ on a daily and annual basis, respectively [14]. Although Turkiye announced on September 22, 2021 that it had lowered the guideline values recommended by the WHO, daily and annual limit values for carcinogenic $PM_{2.5}$ have not been determined in the air quality legislation [14]. In this guideline update recommendations for air quality guideline levels are set as interim targets for the following pollutants as shown in Table 1.

Table 1. Interim target guideline values established for long- and short-term air quality [13]

Pollutant	Average Time	Interim Target (µg/m³)			
		1	2	3	4
$PM_{2.5}$	Annual	35	25	15	10
	24 hours	75	50	37.5	25
PM_{10}	Annual	70	50	30	20
	24 hours	150	100	75	50

Since the Global update, the number of studies on air quality and health has increased significantly, including new studies published after the completion of the systematic reviews conducted for this update. Taken together the guidelines are informed by numerous epidemiological studies that shed light on air pollution exposure risks at both the lower and upper limits of concentration-response relationships for classical air pollutants including the shapes of such relationships [13].

Şanlıurfa province which is in the desert convection zone it exposed to PMs due to dust carried by winds coming from the Sahara, Syria and the Arabian peninsula. Determining the pollutant levels that students, staff and civilians on the campus may be exposed to during their daily activities is very important for both the people operating on the campus and the planning of future studies. The aim of this study is to determine PM levels in Osmanbey Campus which is 22 km away from the city center to measure atmospheric $PM_{2.5}$ and PM_{10} concentrations and to evaluate seasonal and spatial changes. It is aimed to conduct multidisciplinary studies with the results obtained.

II. MATERIALS AND METHOD

A. Study Area

Harran University Osmanbey Campus was built on a land of 27,000 decares bordering the Şanlıurfa-Mardin Highway. The distance between the city center and the campus is approximately 23 km and transportation is provided by buses for approximately 45 minutes. In addition, Şanlıurfa Harran University Research and Application Hospital with a capacity of 684 beds, Hacer Ana Dormitory with a capacity of 1.100 people and Harran Dormitory with a capacity of 1.044 people operate within the campus. Together with its total employees, the university has a population of approximately 35,000 people. 40 different points within the campus borders have been determined to measure $PM_{2.5}$ and PM_{10}. The study area is shown in Figure 3.

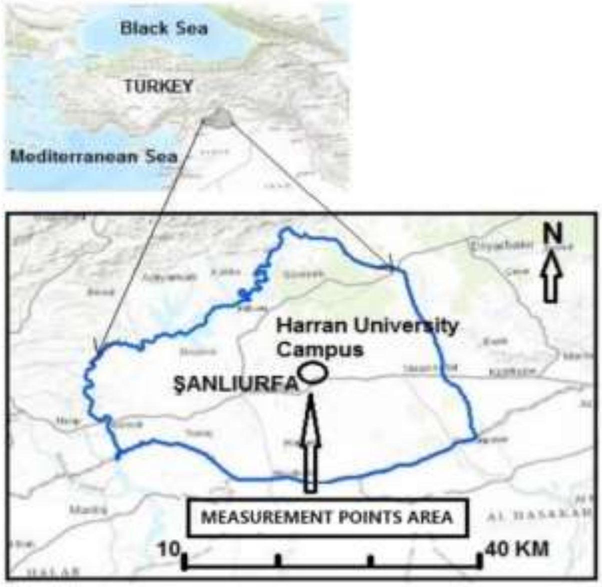

Figure 3.Study area [3]

B. Measurement Points and Data Analysis

ArcGIS software was used during mapping and interpretation of the results. With this program data can be analyzed in detail and shared location-based insights using contextual tools for mapping and spatial reasoning. The 40 determined measurement stations are shown on the map in Figure 4.

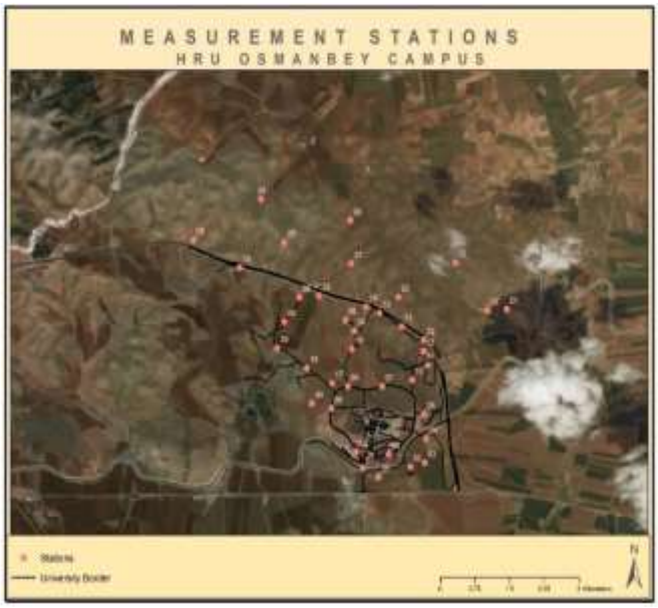

Figure 4. Osmanbey campus PM measurement points

Measurements were taken at 40 different points with the Thermo Scientific Personal DataRAM pDR-1500 device (Figure 5) to determine the PM levels to which students, university staff and civilians studying on the Osmanbey campus were exposed.

Figure 5. An image during measurement with Thermo Scientific Personal DataRAM pDR-1500 device

$PM_{2.5}$, PM_{10}, temperature and relative humidity of the environment are measured with the Termo Scientific pDR 1500 personal DataRam device. The device is operated using two different heads. General features of the device are available in Table 2.

Table 2. Thermo Scientific pDR 1500 personal DataRam device features

Flow Rate	1.0 to 3.5 L/min
Kesinlik	±%5 precision
Aerodynamic Particle Cut-Point Range	1,0 ila 10 µm
Certifications/Compliance	Suitable for NIOSH Methods 0500 and 0600
Concentration Display Averaging Time	1 to 60 sec. (user selectable)
Concentration Display Updating Interval	1 sec.
Concentration Measurement Range	0,001 to 400 mg/m^3 range
Description	personalDataRAM pDR-1500 Aerosol Monitor
Particle Size Range	0,1 to 10 µm

In this study, PM_{10} and $PM_{2.5}$ measurements were carried out in two periods, 2019 November and 2020 April using the Thermo Scientific Personal DataRAM pDR-1500 device at 40 different points determined in Osmanbey campus.

III. Results

PM concentrations, relative humidity and temperature data obtained from measurements made at 40 points within the borders of Osmanbey campus between 2019 November and 2020 April are given in Table 3.

Table 3. Results from 40 measurement points

	2020 APRIL				2019 NOVEMBER			
MP	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	˚C	RH	$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	˚C	RH
1	46,79	76,09	23	43	36.51	63.70	28	31
2	27,37	36,32	23,3	42	13.94	26.75	31,6	29
3	16,64	25,73	21,8	57	19.19	28.66	31,3	30
4	14,13	16,52	22,8	45	14.40	36.39	32,5	28
5	42,28	78,38	27,9	41	39.46	70.08	31,5	28
6	34,19	55,69	29,5	29	35.35	55.45	29,7	29
7	19,85	16,93	28,5	22	9.80	19.74	27,2	33
8	15,13	44,27	25,5	16	17.58	32.15	17	50
9	22,19	37	31,3	27	15.35	39.26	23,6	32
10	43,67	65,18	26,5	40	39.29	58.57	30,8	29
11	26,33	37,38	29,7	29	11.18	22.52	28,4	33
12	25,92	36,78	35,2	21	18.57	25.96	29,2	30
13	32,4	57,48	32,5	28	37.26	60.61	27,5	35
14	30,8	63,57	19,8	26	34.86	68.94	18,5	45
15	36,66	61,5	30,1	22	32.95	64.90	26,8	34
16	33,86	60,78	29,8	24	38.65	62.44	17	53
17	11,15	20,62	28,5	32	9.92	16.58	20,5	44
18	16,04	25,98	25,5	29	12.99	23.73	22,4	39
19	19,74	44,49	26,3	16	15.00	41.32	27	35
20	22,52	37,42	32,3	25	16.38	30.86	26,9	28
21	29,57	38,48	34,9	22	17.00	30.68	29	32
22	17,02	25,35	26,9	23	8.71	12.66	22	43
23	18,2	23,49	20,9	25	6.72	20.20	18	48
24	10,84	23,47	32,8	21	10.18	16.58	25,5	28
25	25,66	34,17	24,8	19	16.18	29.91	28,6	31
26	11,55	22,32	28,4	24	16.18	29.47	28,2	30
27	16,2	21,54	27,5	26	7.03	11.34	27,7	25
28	15,2	30,96	24,2	20	8.30	14.73	23,9	29
29	12,15	24,58	30,2	21	6.50	10.19	23,1	27
30	28,21	37,42	37,5	22	11.74	22.90	24,5	27
31	26,16	37,24	29,7	29	13.03	33.61	31	29
32	35,2	67,17	32,3	28	34.58	54.92	26,1	28
33	11,1	27,75	20,4	28	13.90	30.17	23,3	42
34	35,69	65,75	27	22	23.75	36.46	27,5	27
35	21,67	36,72	23,5	42	8.46	16.86	25,1	28
36	16,22	32,72	29,2	21	14.74	26.43	27,4	31
37	15,98	21,96	31,8	21	9.57	16.38	27,1	26
38	24,35	44,65	36,3	22	14.96	23.49	25,5	27
39	28,65	39,92	34,2	21	12.56	23.28	23,8	30
40	29,29	45,05	32,4	27	10,50	27.48	32,1	43

MP: Measurement Point, RH: Relative Humidity

Pollution concentration maps were created by entering the data obtained from measurements taken in the outdoor environment into the ArcGIS program. $PM_{2.5}$ measurement results obtained as a result of the measurement made in 2019 November are shown in Figure 6.

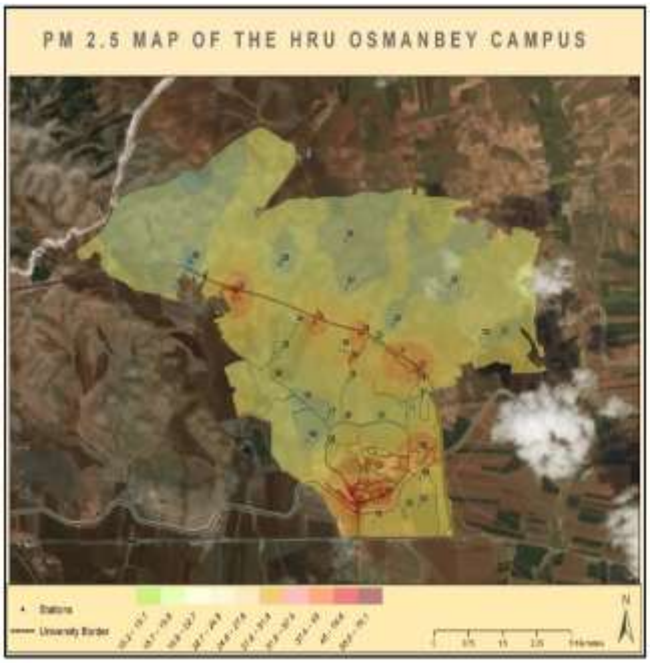

Figure 6. $PM_{2.5}$ concentration values in November 2019

Highest $PM_{2.5}$ concentrations in November 2019; Point 1 is 36.51 μg/m^3, Point 5 the road passing in front of the Faculty of Agriculture and used by ring vehicles is 39.46 μg/m^3, Point 10 hospital point is 39.29 μg/m^3, Point 13. Highway side 37.26 μg/m^3, Point 14 Şanlıurfa-Mardin highway 34.86 μg/m^3, Point 15 Şanlıurfa-Mardin highway 32.95 μg/m^3, Point 16 Şanlıurfa-Mardin highway 38.65 μg/m^3 and Point 32 Şanlıurfa-Mardin highway was measured as 34.58 μg/m^3. 2019 November PM_{10} concentrations obtained from the measurements are shown on the map in Figure 7.

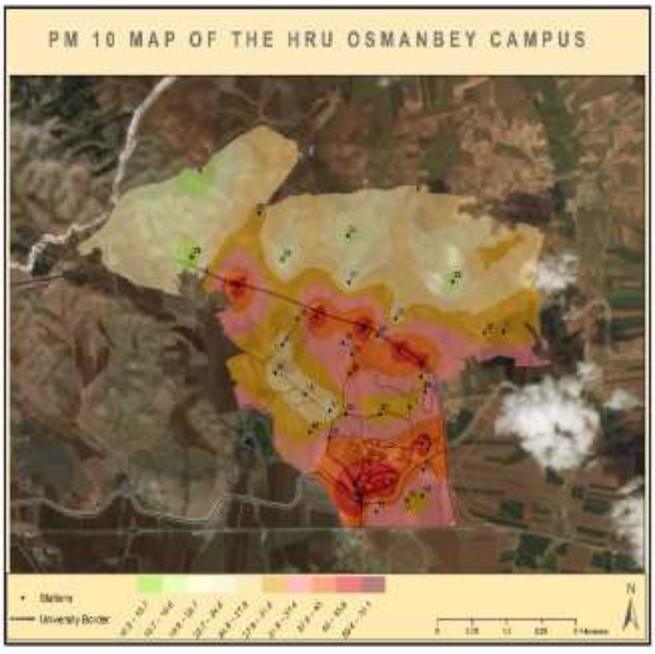

Figure 7. PM_{10} concentration values in November 2019

Points where PM_{10} value was high in November 2019, Point 1 is 63.70 μg/m^3, Point 5 the road passing in front of the Faculty of Agriculture and used by ring vehicles is 70.08 μg/m^3, Point 10 (Hospital point) is 58.57 μg/m^3, 13. Şanlıurfa - Mardin highway 60.61 μg/m^3, Point 14 Şanlıurfa - Mardin highway 68.94 μg/m^3, Point 15 Şanlıurfa-Mardin highway 64.90 μg/m^3, Point 16 point Şanlıurfa -Mardin highway 62.44 μg/m^3 and at Point 32 was measured as 54.92 μg/m^3. The map view of $PM_{2.5}$ values determined as a result of campus measurements made in 2020 April is as seen in Figure 8.

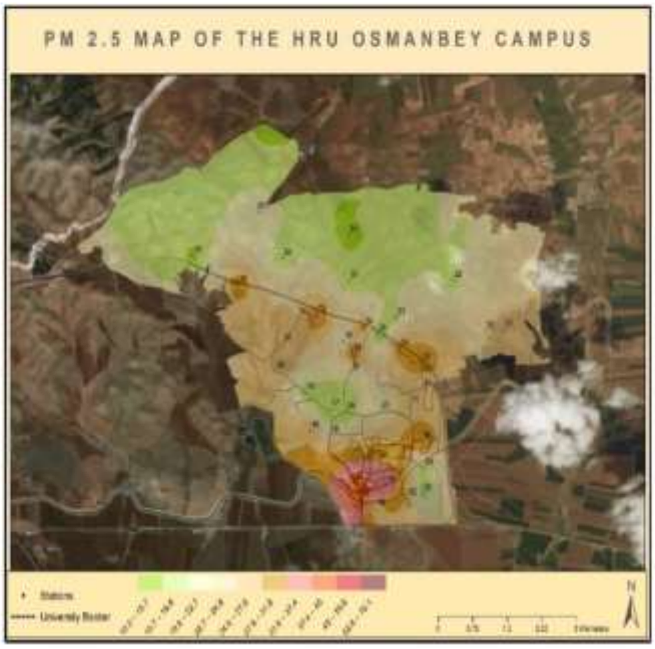

Figure 8. $PM_{2.5}$ concentration values in April 2020

As a result of the measurements, the highest $PM_{2.5}$ values measured in April 2020; Point 1 Campus entrance 46.79 μg/m^3, Point 5 the road passing in front of the Faculty of Agriculture and used by ring vehicles is 42.28 μg/m^3, Point 10 the road in front of the hospital is 43.67 μg/m^3, Point 13 Highway side 32.4 μg/m^3, Point 14 Şanlıurfa - Mardin highway 30.8 μg/m3, Point 15 Şanlıurfa - Mardin highway 36.66 μg/m^3, Point 16 Şanlıurfa-Mardin highway 33.86 μg/m^3, Point 32 Şanlıurfa - Mardin highway 35.2 μg/m^3, Point 34 road to residential areas 35.69 μg/m^3 and Point 40 agricultural area 29.29 μg/m^3. The data collected for PM_{10} in 2020 April is shown on the map in Figure 9.

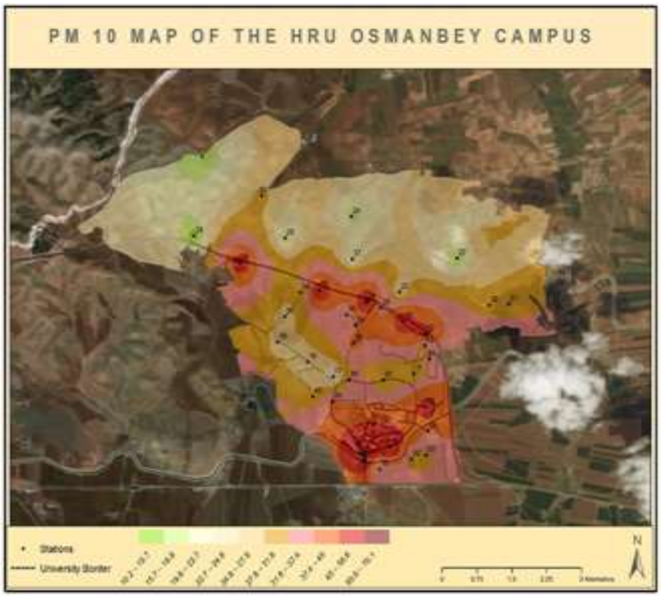

Figure 9. PM_{10} concentration values in April 2020

Points where the PM_{10} parameter is above the standard value in April 2020 was determined as; Point 1 campus entrance 76.09 µg/m^3, Point 5 the road passing in front of the Faculty of Agriculture and used by ring vehicles is 78.38 µg/m^3, Point 6 in front of BESYO is 55.69 µg/m^3, Point 10 The road in front of the hospital is 65.18 µg/m^3, Point 14 Şanlıurfa-Mardin highway 63.57 µg/m^3, Point 15 Şanlıurfa-Mardin highway 61.5 µg/m^3, Point 16 Şanlıurfa-Mardin highway 60.78 µg/m^3, Point 32 Şanlıurfa-Mardin highway 67.17 µg/m^3 and Point 34 the road to residential areas 65.75 µg/m^3.

IV. Discussions

A. *2019-November Autumn Seasons*

While the $PM_{2.5}$ concentration value in November 2019 was 39.46 µg/m^3 at the road point passing in front of the Faculty of Agriculture, which is the Point 5, and used by ring vehicles, the PM_{10} value was the station with the highest concentration with 70.09 µg/m^3. It is thought that the highest values are measured at this point, as this point is a road heavily used by both intra-campus buses, civilian vehicles and tractors within the campus.

The highest $PM_{2.5}$ values in November are Point 5 and Point 10 (39.46 µg/m^3 and 39.29 µg/m^3, respectively). This may be due to the fact that Point 5, which is the road passing in front of the Faculty of Agriculture and used by ring vehicles, is very busy in terms of vehicle use. Considering that the road leading to the Hospital entrance, which is Point 10, shares the entrance point of the campus, it is thought that the high values may be due to this.

Again for PM_{10}; Point 8 was measured as 32.15 µg/m^3 and Point 9 was measured as 39.26 µg/m^3, and although Point 8 was a road passing through agricultural areas, it was observed that it did not exceed the national limit value of 50 µg/m^3. The PM_{10} concentration at the Hospital point, selected as Point 10, exceeded the limit value with 58.57 µg/m^3. The road leading to the hospital entrance shares the entrance point of the campus, and it is thought that this is due to the fact that private vehicles of civilians going to the hospital are densely located on the Point 10 route. For this reason, vehicle traffic is quite high in this region. As a result, the measured value was higher than the limit value.

For $PM_{2.5}$; The highest concentrations were measured at Point 13 (37.26 µg/m^3), Point 14 (34.86 µg/m^3), Point 15 (32.95 µg/m^3), and Point 16 (38.65 µg/m^3). The reason why the PM_{10} value is 62.44 µg/m^3 on the Point 16 Şanlıurfa-Mardin highway and 54.92 µg/m^3 on the Point 32 is that the Şanlıurfa-Mardin main road passes through the campus and is generally due to the use of transportation vehicles such as trucks. As can be seen in Figure 7, PM_{10} values were high on the same road route, and the reason for this was shown to be the movement of vehicles. The reason why the PM_{10} value is high at these points is that the Şanlıurfa-Mardin main road passes through the campus and this is generally due to the use of transportation vehicles such as trucks.

Dursun et al. [15] interpreted it in the same way in their study at Konya Selçuk University in 2017. While the number of 85,000 students studying at Turkiye third largest Campus is measurements carried out at 40 points have also determined that the amount of PM is high in places and hours with heavy traffic. In 2019, Mageshkumar and Ramesh [16], tried to determine the air quality in university campus, public hospital and bus stops in Tamilnadu, India. As a result of their analysis, the PM_{10} value was 106.56-115.58 µg/m^3; They found that the $PM_{2.5}$ value varied between 48.55-59.52 µg/m3. They compared the results of this analysis with the National Ambient Air Quality Standards (NAAQS) and found that the PM_{10} concentration exceeded the limit value and reported that one of the reasons for this was vehicle density. PM_{10} and $PM_{2.5}$ concentrations in the Business Area of Harcourt University of Nigeria Abuja Campus were measured in certain months and some values were found to be between 51.75 µg/m^3 (minimum) and 428 µg/m^3 (maximum) for PM_{10}; They found that $PM_{2.5}$ varies between 24.13 µg/m^3 (minimum) and 203.63 µg/m^3 (maximum). It has revealed that the air quality in the Business Area of the University of Harcourt Abuja Campus has deteriorated and poses a major risk to human health. It has been determined that as a result of long-term exposure, cases of respiratory and cardiovascular problems may increase in the exposed population [17].

B. *April- 2020 Spring Seasons*

In April 2020, $PM_{2.5}$ and PM_{10} values at Point 1, the campus entrance, were measured as 46.79 µg/m^3 and 76.09 µg/m^3, respectively. It is thought that $PM_{2.5}$ and PM_{10} concentrations are high because this point is located at the entrance of the university, the bus arrival-departure point, and the road leading to the campus hospital is also at this point.

While the $PM_{2.5}$ concentration is 42.28 µg/m^3, since the Point 5 is located on the road actively used by on-campus ring cars and vehicles passing in front of the Faculty of Agriculture; PM_{10} concentration was measured as 78.38 µg/m^3. It is thought that the reason for the high $PM_{2.5}$ concentration at these points is that the on-campus ring vehicles that provide short-distance transportation on campus and the private vehicles of civilians going to the hospital are densely located on the Point 10 route.

$PM_{2.5}$ and PM_{10} concentrations were evaluated in 5 outdoor and 12 indoor areas at the Payambar Azam Campus of Mazandaran University of Medical Sciences, located in Sari city of Northern Iran. Measurements were made in four university buildings as indoor areas, including classrooms, corridors and offices. Outdoor PM concentrations were monitored at five locations around the university campus. It shows that indoor concentrations of the $PM_{2.5}$ parameter are generally higher than outdoor concentrations [18].

In another study conducted in China, measurements were made on the main campus and Liangxiang campus of the Beijing Institute of Technology. Local air pollution sources around these two campuses were examined during three study periods. As a result of the analysis, PM_{10} in the suburban area is 134 µm/m^3, $PM_{2.5}$ is 75.2 µm/m^3, and PM_{10} in the urban area is 111 µm/m^3; $PM_{2.5}$ was determined to be 56 µm/m^3 [11].

This study contributed to the literature on outdoor air quality in university campuses. The outdoor air quality also serves as an infrastructure study regarding the indoor air quality of the buildings, classrooms, libraries, dormitories, cafes, canteens and even dining halls within the campus. As a supporting information [19], in a study covering the Osmanbey campus, $PM_{2.5}$, PM_{10}, CO_2, temperature and relative humidity measurements were made to determine indoor pollution levels. As a result of the study, it was concluded that the indoor air quality in the Osmanbey campus was better than the Eyyübiye campus, which is a 33-year-old building and closer to the center and rural areas, due to its distance from the city center.

V. CONCLUSION

This study was carried out to determine the outdoor air quality of the Osmanbey Campus area in Şanlıurfa province. Considering the fact that the campus borders the Mardin-Şanlıurfa highway, the increased vehicle density due to the hospital within the campus, and the daily services of the ring buses within the campus, the formation of air pollution has become inevitable, as it is on the route of long-range dust carried from the Sahara desert region of Şanlıurfa. To summarize, we aimed to contribute to the conduct of multidisciplinary studies with the data obtained from PM measurement results in the Osmanbey campus.

REFERENCES

[1] Buchunde, P., Safai, P. D., Mukherjee, S., Leena, P. P., Siingh, D., Meena, G. S.,& Pandithurai, G. ‘’Characterisation of particulate matter at a high-altitude site in southwest India: Impact of dust episodes’’, *Journal of Earth System Science, 128(8), 237*, 2019.

[2] (2022) UVCFAN Website. [Online]. Available: https://uvcfan.com/partikul-olcum-cihazi/

[3] DOGAN, T.R., & YALCIN, S.P. ‘’The Atmospheric Transported Desert Dust Over Sanliurfa (Turkey) and its Structural Properties’’, *Sigma Journal of Engineering and Natural Sciences, 38(4), 1837-1848*, 2020.

[4] C. Textor, M. Schulz, S. Guibert, S. Kinne, Y. Balkanski, S. Bauer, T. Berntsen, T. Berglen, O. Boucher, M. Chin, F. Dentener, T. Diehl, R. Easter, H. Feichter, D. Fillmore, S.

Ghan, P. Ginoux, S. Gong, A. Grini, J. Hendricks, L. Horowitz, P. Huang, I. Isaksen, I. Iversen, S. Kloster, D. Koch, A. Kirkevåg, J.E. Kristjansson, M. Krol, A. Lauer, J.F. Lamarque, X. Liu, V. Montanaro, G. Myhre, J. Penner, G. Pitar, S. Reddy, Ø. Seland, P. Stier, T. Takemura, X. Tie, ‘’Analysis and quantification of the diversities of aerosol life cycles within AeroCom’’, *Atmospheric Chem. And Physics*, 6, (7), 2006.

[5] N. Huneeus, M. Schulz, Y. Balkanski, J. Griesfeller, J. Prospero, S. Kinne, S. Bauer, O. Boucher, M. Chin, F. Dentener, T.Diehl,R.Easter, D. Fillmore, S. Ghan, P. Ginoux, A. Grini, L. Horowitz, D. Koch, M.C. Krol, W. Landing, X. Liu, N. Mahowald, R. Miller, J.-J. Morcrette, G. Myhre, J. Penner, J. Perlwitz, P. Stier, T. Takemura, C.S. Zender, ‘’Global dust model intercomparison in AeroCom phase I’’, *Atmos. Chem. Phys.*, *11*, pp. 7781, 2011.

[6] P. Ginoux, J.M. Prospero, T.E. Gill, N.C. Hsu, M. Zhao, ‘’Global-scale attribution of anthropogenic and natural dust sources and their emission rates based on MODIS Deep Blue aerosol products’’, *Rev. Geophys.*, 50, 2012.

[7] Kok, J. F., Ridley, D. A., Zhou, Q., Miller, R. L., Zhao, C., Heald, C. L., ... & Haustein, K. ‘’Smaller desert dust cooling effect estimated from analysis of dust size and abundance’’, *Nature Geoscience*, *10(4)*, *274-278*, 2017.

[8] Lozano, R., Naghavi, M., Foreman, K., Lim, S., Shibuya, K., Aboyans, V., ... & AlMazroa, M. A. ‘’Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010’’. *The lancet*, *380(9859)*, *2095-2128*, 2012.

[9] Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., ... & Aryee, M. ‘’A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010’’. *The lancet*, *380(9859)*, *2224-2260*, 2012.

[10] LANDRİGAN, P. J.. ‘’Air pollution and health.‘’ The Lancet Public Health, 2(1), e4-e5, 2017.

[11] Wu, S., Deng, F., Hao, Y., Shima, M., Wang, X., Zheng, C., ... & Qin, Y. ‘’Chemical constituents of fine particulate air pollution and pulmonary function in healthy adults: the Healthy Volunteer Natural Relocation study’’, *Journal of hazardous materials*, 260, 183-191, 2013.

[12] WU, W., JİN, Y. and CARLSTEN, C. ‘’Inflammatory health effects of indoor and outdoor particulate matter’’, *Journal of Allergy and Clinical Immunology*, 141(3), 833-844, 2018.

[13]World Health Organızatıon, (2021). Homepage on WHO. ‘’WHO global air quality guidelines: particulate matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogendioxide, sulfurdioxide and carbonmonoxide’’,Available:https://www.who.int/publications/i/item/9789240034228.

[14] Temiz Hava Hakkı Platformu, (2020). Kara Rapor, Hava Kirliliği ve Sağlık Etkileri. Available: https://www.temizhavahakki.org/kararapor2020/?utm_source=aposto.

[15] Dursun, Ş., Ayturan, Z., Kunt, F., Ulusoy, Ç., & Mesutoğlu, Ç. ‘’Selçuk Üniversitesi yerleşkesi açık alanlarda ortam PM2. 5 seviyesinin belirlenmesi’’ *VII. ulusal hava kirliliği ve kontrolü sempozyumu*, 190-202, 2017.

[16] Mageshkumar, P., Ramesh, S., & Senthil, K. A. ‘’Ambient Air Quality Monitoring Studies in Four Specific Location of Tamilnadu, India, 2019’’, *Internatıonal Research Journal Of Multıdıscıplınary Technovatıon (Irjmt)*, ; 1(6); 677-683, 2019.

[17] Ugbebor, J. N., Yorkor, B., & Amadi, G.. ‘’Assessment of air quality and its health implications on Abuja campus residence, University of Port Harcourt, Nigeria’’, *Journal of Science, Technology and Environment Informatics*, *7*(01), 500-509, 2019.

[18] Mohammadyan, M., Ghoochani, M., Kloog, I., Abdul-Wahab, S. A., Yetilmezsoy, K., Heibati, B., & Pollitt, K. J. G. ‘’Assessment of indoor and outdoor particulate air pollution at an urban background site in Iran’’, *Environmental monitoring and assessment*, 189(5), 235, 2017.

[19] Tuba Rastgeldi Dogan, *New Approaches to Spatial Planning and Design*, Murat Özyavuz ed., Berlin, Germany: Peter Lang, 2019.