# Distribution of Particulate Matter ($PM_{10}$) Concentration in Lashio University Campus of Lashio, Myanmar

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## Abstract

Air pollution's impact on human health arises from inhaling high amounts of harmful substances in the atmosphere. Especially, all people understanding of the damage caused by $PM_{10}$ pollutants is improving daily. This study aims to measure and analyze $PM_{10}$ pollution in the Lashio University campus. The PM concentration was measured using the Pocket $PM_{10}$ sensor three times (7:00 h, 13:00 h, and 19:00 h) for 15 min/day for 3 days, the last week of the month, 2021 December and 2022 September, in front of the main building. The results showed that the highest $PM_{10}$ concentrations were found in February in the morning (mean 223.67±5.41μg/m$^3$), but the highest concentrations in the afternoon (93.80±5.67μg/m$^3$) and evening (178.44±5.23μg/m$^3$) were found in March. The second high concentration was found in February, in the afternoon and evening. In May, June, July, and August, the lowest $PM_{10}$ concentrations were observed in the morning, afternoon, and evening. $PM_{10}$ concentrations at different times of the day except the morning, afternoon, and evening periods were below the USEPA guideline value for $PM_{10}$ (150μg/m$^3$, 24h mean). In this study, the high $PM_{10}$ concentration results show, the air quality on the Lashio University campus was in good condition.

Keywords - $PM_{10}$, Lashio University campus, mobile pocket sensor.

## Introduction

Particulate matter (PM), which has adverse effects on human health (Triantafyllo, E and Biskos, G 2012). Many studies have been performed in recent years concerning total suspended particles in ambient air and the health risks caused by exposure to these particles. Some of these investigations focused on the relationship between respirable particles and their adverse effects on health (Adgate, J. *et. al.*, 2007) Other studies emphasized the importance of finer particles since they are easily respired and deposited in the lungs, causing problems with the respiratory system and increased mortality (Schwartz and Joel., 1996) Toxicity of the particles is related to their size and elemental composition. Particles with diameters <10 ($PM_{10}$) are especially important because of their ability to penetrate into the alveoli of lungs Brunekreef, B and Holgate S.T., 2002). Several recent studies have documented associations between the day to day variation of air pollution by particulate matter and acute health effects on children, including increased respiratory symptoms and decreased lung function (Pop, C.A. and Dockery, D.W., 2006).The sources include energy production from fossil fuel or biomass combustion, road traffic, shipping emissions, home and utility building heating, industrial production, agricultural emissions, and others. These sources not only produce pollutants directly (primary emissions) but they also produce so-called precursor gases which, through atmospheric reactions, produce secondary pollutants WHO 2016. Particulate matter (PM) is one of the most common air pollutants and a complex mixture of extremely small particles and liquid droplets made up of acids, organic chemicals, metals, and soil or dust particles (WHO 2016). Particle size is an important determinant of the size and efficiency of pulmonary deposition, but particle size is also a surrogate for particle source and composition. $PM_{10}$ consists mainly of crustal particles mechanically generated from agriculture, mining, construction, road traffic, and

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related sources, as well as particles of biological origin. Air pollution is usually characterized by visibility, and the degree of pollution can be roughly discriminated through visual inspection. We can simply guess the air quality by observing whether the sky is blue, or the edges of distant buildings through the taken images. Researches have proved that the level of visibility is not only a natural phenomenon, but also closely related to human activities and the interaction of pollutants ($PM_{2.5}$, $PM_{10}$, etc.) with meteorological factors such as water vapor, wind, temperature, and pressure (Ma Z., *et al.*,2014). $PM_{10}$ consists mainly of combustion particles from motor vehicles and the burning of coal, fuel oil, and wood, but also contains some crustal particles from finely pulverized road dust and soils. Concentrations of $PM_{10}$ in the air of downtown Yangon City in Myanmar have recently been published; $PM_{10}$ concentrations were within the US EPA national ambient air quality standard of 150 $\mu g/m^3$ 24hr mean at all sampling sites (Yi, EEPN., *et al.*, 2020). $PM_{10}$ can stay in the atmosphere for a long time and travel for a long distance. Therefore, it has a greater impact on human health and the quality of the atmospheric environment (WHO 2013). In the world, it has always been a hot topic in various related research fields around the environment. In this study, to investigate the concentrations, distributions, and potential sources of $PM_{10}$ in the environment in the Lashio University campus and to assess the risks posed by $PM_{10}$ to the inhabitants of that campus.

## Materials and Method

Pocket $PM_{10}$ Sensors (Yaguchi Electric Co., Ltd., Miyagi, Japan) were used for the measurement of concentrations of $PM_{10}$ as described previously (Yi. EEPN., *et.al*., 2018) This pocket sensor can measure and display $PM_{10}$ concentrations at the same time. The sensor has a laser LED (light-emitting diode), a PD (photodiode) sensor, a fan, amplifier, and USB (Universal Serial Bus) encoder. The sensor can generate log data in CSV (comma-separated values) of Google KML (Keyhole Markup Language) format including GPS (Global Positioning System). In this study, the portable sensor has to be connected to a smart phone with an android system. Yi, EEPN., *et.al*., 2018 and Mon, EE., *et al*., 2021 results show the phone displays $PM_{10}$ concentrations in microgram per cubic meter and phone screen color changes from blue, to yellow, red, purple and black with increasing values of $PM_{10}$ (Figure. 2).


Fig.1 Location of sampling area in Lashio University campus, Northern Shan State, Myanmar

Air Sample Collection

Sampling was collected in areas in front of the Lashio University graduation hall (Figure. 1). This study was carried out for 3 consecutive days, last week of the month (December 2021, January, February, March, April, May, June, July, August, and September 2022) in the cold, summer, and rainy seasons. The investigators measured the $PM_{10}$ concentrations at these areas three times a day (7:00 h, 13:00 h, and 19:00 h) for 15 minutes.

(a)


(a) Pocket $PM_{10}$ sensor with smart phone

(b) Real-time assessment of various $PM_{10}$ levels shown by color intensity.


Fig. 2 Description of $PM_{10}$ Sensor

## Results and Discussion

The minimum, maximum, and mean $PM_{10}$ concentrations of Lashio University campus area were shown in Table 1. The concentrations varied at different times and different seasons of the day, with the maximum concentration of $PM_{10}$ in the morning and the minimum concentration in the afternoon in all seasons. Among eight months (Figure 3 and 4), it was observed that February and March had the highest $PM_{10}$ mean concentrations (223.67±56.41μg/m$^3$) in the morning and (178.44±5.23μg/m$^3$) in evening, followed by the second highest $PM_{10}$ mean concentrations found in March (199.78±47.80 μg/m$^3$) in the morning and December (161.49±7.75 μg/m$^3$) in the evening, as shown in Table 1.

At the end of the cold season, currently, the burning of dry leaves and trash is common place across the city, including at military compounds, university campuses, schools, and monasteries in Myanmar. These study areas, including universities, are located between monasteries and the army. Lashio is the largest town in Northern Shan State, Myanmar. This study area is located on the main trading road connecting China and central Myanmar. Moreover, this study area was located in the downtown area and beside the road. In this study, it cannot be declined that an increase in traffic congestion and roadside snacks and restaurants increases PM concentration levels and thus exacerbates the risks of various diseases to human health. Moreover, there was just a small amount of natural conditions or weather (trees, ponds, and green areas) that prevented the dust pollution. Therefore, natural conditions should be maintained and more additions made to the Lashio University campus. In Lashio, the summers are short, hot, and mostly cloudy, and the winters are short, cool, dry, and mostly clear (Soe, KK., et al.,2018).

Table 1. $PM_{10}$ concentrations (µg/m$^3$) in Lashio University campus, Myanmar

| Month | Morning<br>Mean (µg/m$^3$)<br>Max~Min | Afternoon<br>Mean (µg/m$^3$)<br>Max~Min | Evening<br>Mean (µg/m$^3$)<br>Max~Min |
|---|---|---|---|
| December | 122.32± 25.73<br>82.54~207.64 | 39.34±3.12<br>34.50~49.04 | 161.49±7.75<br>145.37~180.87 |
| January | 130.29±12.84<br>110.40~151.27 | 31.75±1.78<br>24.54~36.64 | 121.05±5.18<br>101.77~130.80 |
| February | 223.67±56.41<br>121.87~294.20 | 40.65±2.38<br>36.20~47.47 | 81.26±6.67<br>61.27~99.70 |
| March | 221.86±12.59<br>160.70~238.50 | 93.80±5.67<br>73.87~108.70 | 178.44±5.23<br>162.47~191.17 |
| April | 85.17±3.29<br>78.80~94.80 | 38.94±0.77<br>36.67~41.40 | 78.42±2.92<br>71.14~86.17 |
| May | 85.17±5.29<br>40.27~62.87 | 38.94±2.23<br>28.77~38.14 | 39.88±2.62<br>34.67~46.80 |
| June | 37.48±10.62<br>25.54~57.27 | 20.97±2.97<br>16.60~35.94 | 40.69±3.94<br>33.44~47.34 |
| July | 55.64±8.74<br>47.24~86.47 | 16.64±2.00<br>13.77~30.47 | 39.75±9.12<br>30.34~44.97 |
| August | 29.05±2.01<br>23.90~33.74 | 30.07±31.27<br>16.87~229.64 | 57.03±15.12<br>39.10~96.44 |
| September | 90.03±16.56<br>61.17~122.20 | 27.53±2.89<br>24.54~42.87 | 140.19±8.83<br>127.00~165.87 |

Data are presented as mean ± SD, (Minimum ~ Maximum)

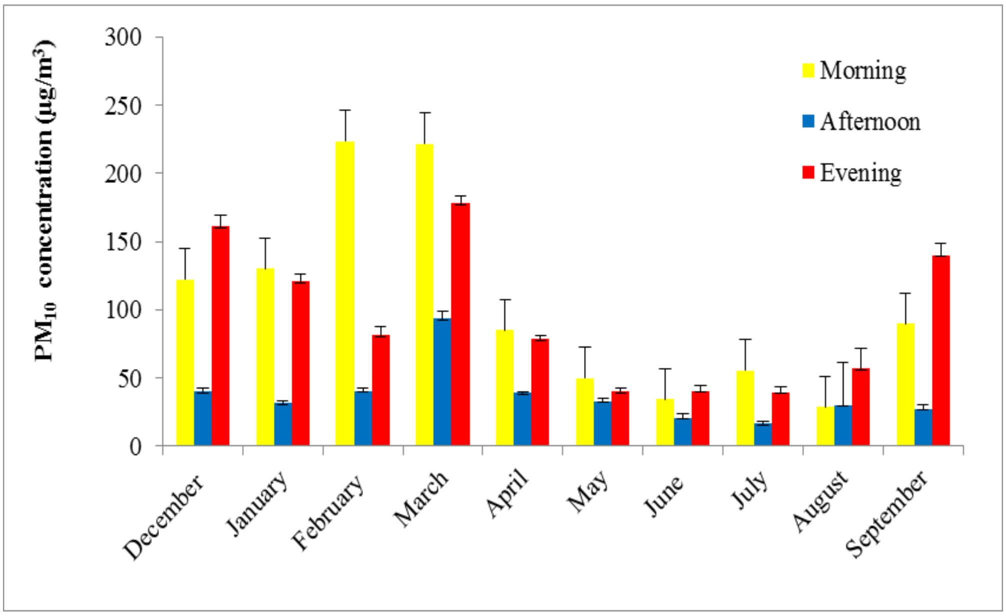


Fig. 3 Distribution of $PM_{10}$ concentration in the Lashio University campus, Myanmar

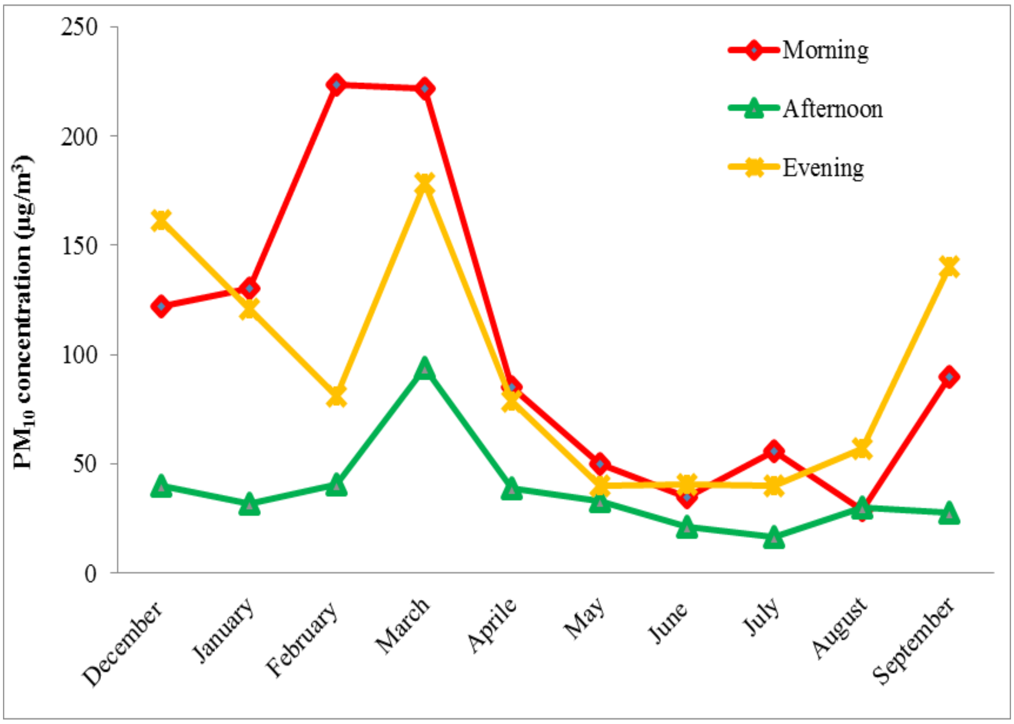


Fig. 4 Changes in air pollution in different months at Lashio University campus

Over the course of the year, the temperature typically varies from 48°F to 92°F and is rarely below 44°F or above 98°F (Soe, KK., *et al.*,2018) As shown in Soe, KK., *et al.*,2018, Lashio City's temperature is increasing year by year, but the tree is declining. Another important consideration was that a lack of greenery intensifies high ambient temperatures. Based on the analysis, the PM concentration in the Lashio University campus area will increase when there is high traffic congestion, human activity, and relative humidity. But if there is high wind speed, the PM concentrations on the Lashio University campus will decrease, and vice versa. The lowest $PM_{10}$ mean concentrations were found in May, June and July. May is the transitional month between the hot and rainy seasons, with high rainfall and severe heat. In the usual manner, in the study area, June to October is the monsoon season, with high rainfall. $PM_{10}$ levels vary with the season. $PM_{10}$ concentration levels were lower in May, June and July than in December, January, February, and March, as shown in figure 4.

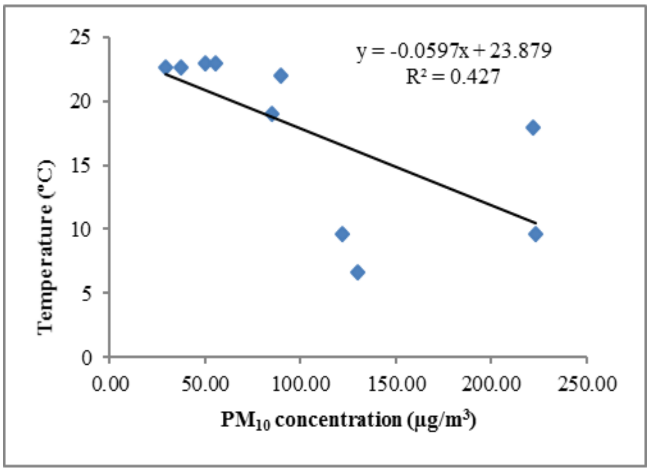


Fig. 5 The correlation between PM10 and temperature in Lashio

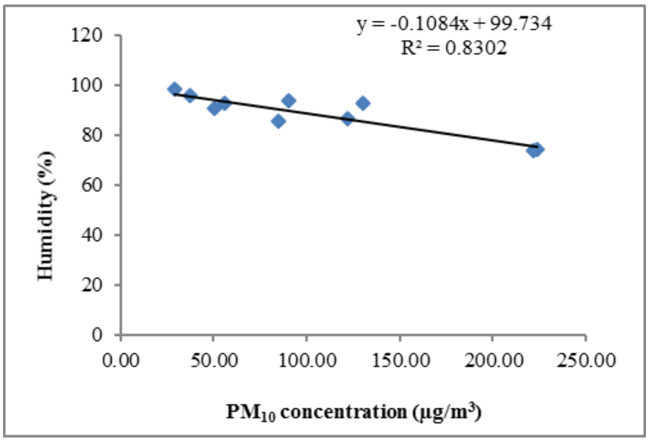


Fig. 6 The correlation between $PM_{10}$ and humidity in Lashio University campus

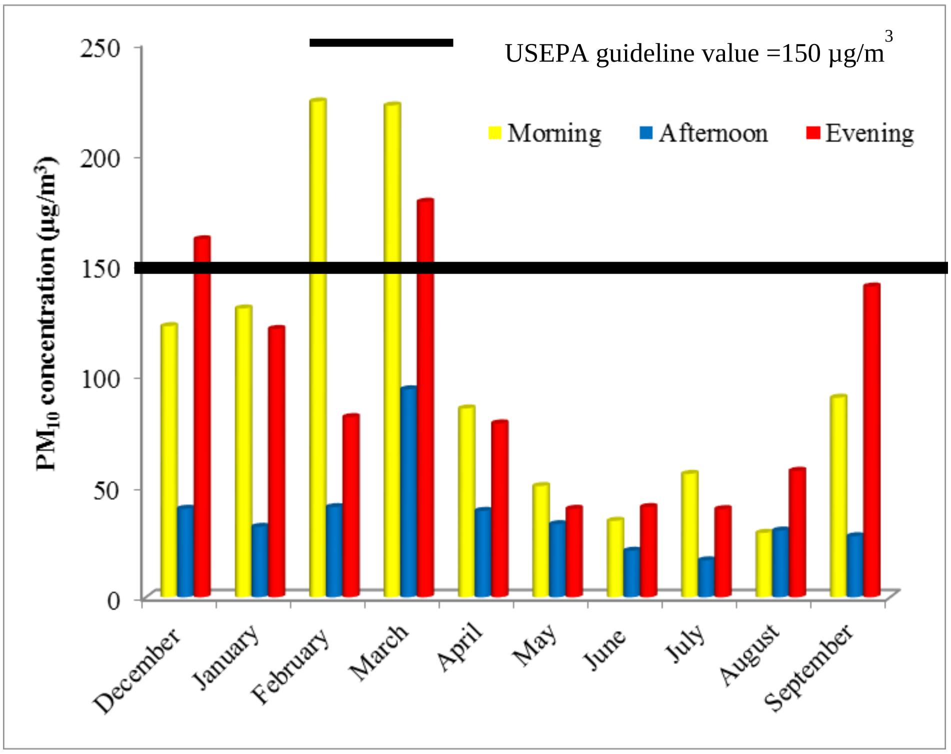


Fig. 7 Comparison of PM10 concentrations of different times of the day with its USEPA guideline values

The temporal series of simultaneous $PM_{10}$ concentrations data in the cold, summer, and rainy seasons have been found to be uncorrelated with temperature ($R^2$ = 0.0427, respectively) Fig.5. The results show that the $PM_{10}$ humidity correlated annually with the correlation coefficient of ($R^2$=0.8302) in the morning, respectively Fig. 6. The purpose of this study was to shed light on the impact of daily air pollution exposure on life expectancy on the Lashio University campus, as well as to systematically evaluate the potential health benefits of known particulate matter concentrations to specific thresholds. The effects of daily $PM_{10}$ pollution exceed the limit value of the USEPA guideline value (150 µg/m$^3$, 24h mean) (Yi, EEPN., *et al*., 2020) in December, February, and March in the evening and morning on the Lashio University campus show as Fig.7. The maximum value of $PM_{10}$ in the morning could be due to the presence of smoke from burning dried leaves and smog in the winter season. According to Kuschel G., *et. al.,* 2012 results, winter is also the time of year when weather conditions that worsen $PM_{10}$ concentrations occur–such as settled conditions and temperature inversions (layers of hot air sitting above cold air near ground level), which restrict the dispersion of pollutants. Conversely, particularly strong wind and unstable weather can quickly disperse pollutants, having a beneficial effect on air quality (Kuschel, G., *et al.*, 2012). Each month had different $PM_{10}$ concentrations at different times of the month except the morning, afternoon, and evening periods of January, April, May, June, July, August, and September, when values were below the USEPA guideline range (Fig. 7). Particulate matter ($PM_{10}$) may be removed from the air by incorporation in rainwater or falling raindrops. Therefore, in the rainy season, low concentrations of $PM_{10}$ were found. These results show no risk potential health benefit could be gained when using the USEPA guideline value as the reference rather than the WHO AQG 2005(USEPA 2005). Vongruaug and Pinonsree (2020), according to the high $PM_{10}$ concentrations found in Laos and Myanmar with monthly area averages of 119 and 115 µg/m$^3$, respectively, whereas in other Asia countries $PM_{10}$ levels in China, Thailand, Vietnam, and Cambodia were found to be 65, 64, 62, and 37 μg/m$^3$, respectively (Fig. 8). These results show that the daily $PM_{10}$ variations recorded for Laos and Myanmar were strongly related to domestic biomass burning emissions (USEPA 2005). Findings from our study indicate that even a little high-level $PM_{10}$ exposure, even for a short time, could not lead to potential loss of life expectancy, and efforts are thus necessary for air pollution control in highly polluted regions. The finding is consistent studies conducted in highly polluted locations in China (Liu. S., *et al.*, 2021) suggesting greater potential health benefits when making additional efforts to reduce $PM_{10}$ concentrations in less-polluted regions or countries. $PM_{10}$ concentrations were found to be higher than the USEPA guideline value in the mornings and evenings of February and March. The study will help formulate seasonal-specific control measures to improve air quality on the Lashio University campus.

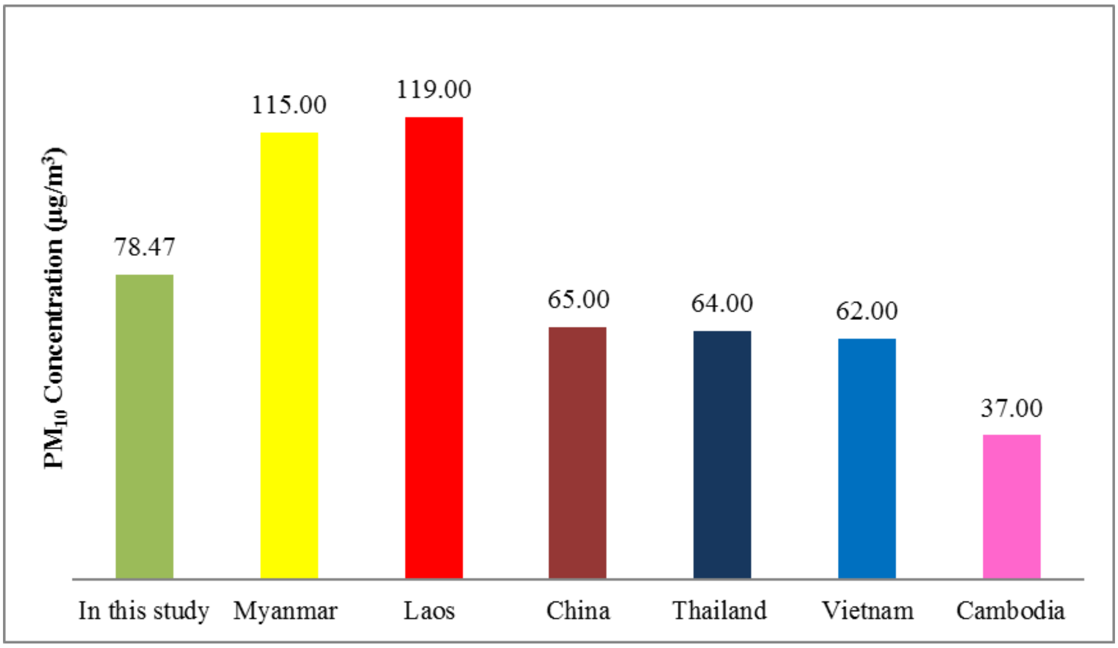


Fig. 8 Compare the distribution of $PM_{10}$ concentrations in Southeast Asian countries.

## Conclusion

The results showed that different concentrations of $PM_{10}$ were found in different months. In this study, poor air quality in terms of $PM_{10}$ pollutant concentrations was found in February and March in the morning. However, in January, April, May, June, July, August, and September, low concentrations of $PM_{10}$ were found. In contrast, other months like January, April, May, June, July, August, and September had low concentrations of $PM_{10}$ values because this time of year was rainy and dry. The recognizable ambient particulate pollution on the Lashio University campus could be contributed to both man-made and natural sources. On the Lashio University campus, air pollution is mainly due to high traffic congestion, unpaved roads, construction, factories, the burning of waste and dried leaves, and roadside mobile food shops. It is possible to conclude that PM10 pollutants can be reduced by avoiding the burning of dry leaves in nearby areas. In these results, some months had high PM10 concentrations, but the results show that the air quality on the Lashio University campus was in good condition.

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