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# INVESTIGATING THE EFFECT OF ALTITUDE AND METEOROLOGICAL PARAMETERS ON THE CONCENTRATION OF PARTICULATE MATTER AT AN URBAN AREA OF KANO STATE, NIGERIA

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***ABSTRACT***

***The impact of Particulate Matter (PM) on the health of individuals when its concentration is much in the atmosphere has been of concern and this has made it a topic of research to monitor its concentration in any given location. The aim of the study is to investigate the effect of altitude and selected meteorological parameters on concentration of Particulate Matter (PM) at an urban location in Kano State, Nigeria. The study was conducted at Dala Hill, which is in Dala L.G.A of kano state in northern Nigeria, at a height of 496, 519 and 530 meters above mean sea level (m.a.s.l) with measurements taken three times per day (morning, afternoon and evening) between November 2020 and February 2021. The PM concentration ($PM_{2.5}$ and $PM_{10}$) and selected meteorological parameters were measured using a handheld particulate matter monitor (PM monitor). The altitude range and barometric pressure were determined using a multifunction digital altimeter. During the study period, the maximum monthly average value of $PM_{2.5}$ and $PM_{10}$ at observation altitude of 496, 519 and 530 (m.a.s.l) are 85.6 and 110.2 $\mu gm^{-3}$, 67.7 and 85.2 $\mu gm^{-3}$ and 42.2 and 54.2 $\mu gm^{-3}$. By considering standard limit given by the Ambient Air Quality Standard (AAQS), it was observed that, the monthly average values of $PM_{2.5}$ concentration were above USEPA 24-hr Standard value while for $PM_{10}$ concentration were below USEPA 24-hr standard value. During the daily observation period, the study showed that, the over-standard limit of daily average value of $PM_{2.5}$ at the observation altitude of 496, 519 and 530 (m.a.s.l) were 96.7%, 81% and 41.3% for the overall period of the study area. While the highest number of daily average values of $PM_{10}$ concentration for the overall period study period were below standard limit except 13% at the observation altitude of 419 (m.a.s.l), 4.3% at 519 (m.a.s.l) and3.3% at 530 (m.a.s.l). These showed that, the $PM_{2.5}$ concentration was higher than that of $PM_{10}$ at the study area. A statistical analysis using Pearson Correlation Analysis showed that PM concentration ($PM_{2.5}$ and $PM_{10}$) has a negative correlation with temperature and relative humidity and positive correlation with barometric pressure. As temperature and relative humidity increases the PM concentration decrease, while as barometric pressure increases the PM concentration also increases. As a general finding, the experimental result showed that, the PM concentration decrease with increasing altitude.***

***KEY WORDS: Altitude, Air quality index (AQI), Particulate Matter (PM), Statistical analysis.***

## INTRODUCTION

The impact of air pollutants in the ambient air is of high concern due to their adverse effect on human health and the environment. Air pollutants are hazardous substances in the air that are produced from natural sources such as radon gas or from anthropogenic sources (man-made) such as combustion for energy production in industry, internal combustion engines and standby generators (Herman Koren, 2002).

However, anthropogenic activities are the major cause of environmental air pollutions. Air pollution is defined as the introduction of physical, chemical or biological substances into the environmental atmosphere that harm humans or other living organisms or deterioration of the natural environment (Bhola *et al*., 2000).

Moreover, Particulate Matter (PM) have a strong impact on more people among all the air pollutant and to be of great concern in health-related effects (Pope & Dockery, 2006). The major constituents of PM are sulfates, nitrates, ammonia, sodium chloride, carbon, mineral dust and water (World Health Organization, 2013). Particulate matter (PM) is a widespread type of air pollutants consisting varying mixtures of solid and liquid particles suspended in the breathing air that vary in number, size, shape, and chemical composition and are produced by a wide variety of natural and anthropogenic activities (Poschl, 2005). Particulate Matter (PM) varies in size (i.e the diameter or width of the particle). $PM_{10}$ refers to inhalable coarse particles with aerodynamic diameter less than 10µm. $PM_{2.5}$ refers to inhalable fine particles with aerodynamic diameter less than 2.5µm (Pope & Dockery, 2006). The major sources of $PM_{10}$ are urban fugitive dust, crustal soil, coal combustion, biomass burning, vehicle emission, sulfate and nitrate (secondary). and the major sources of $PM_{2.5}$ are dust, aerosol (secondary), coal combustion, traffic exhaust and biomass burning (Liu, *et al.,* 2014).

Furthermore, altitude distribution of air born PM consider to be most the important study of air pollutant. There are several works reported in the literature which determine the vertical distribution on air born PM. In the study presented by Deng, measured the PM concentration at two different altitude (121m and 454m) at the Canton Tower in Guangdong province. the result show that, the vertical distribution of PM decreased with increasing altitude (Deng, *et al.,* 2015). Similarly, Peng Study the vertical distribution patterns of $PM_{2.5}$ concentrations based on ambient monitoring with unmanned aerial vehicles in Hangzhou, china. After the analysis it was found that $PM_{2.5}$ concentrations decrease with increasing altitude (Peng, *et al.,* 2015). A reasonable amount of work has also been carried out which investigate the effect of meteorological parameters on PM concentration. Li, investigate the correlation between $PM_{2,5}$ and meteorological parameters in Hong Kong, China. According to the correlation analysis, the result hint that, the $PM_{2.5}$ concentration have a positive correlation with pressure and negative correlation with temperature, relative humidity, rainfall and windspeed (Li, *et al.,* 2017).

Erdogan investigate the relationship between $PM_{10}$ concentration and meteorological parameters. The result showed that, $PM_{10}$ have a positive correlation with relative humidity and negative correlation with air temperature (Erdogan, *et al.,* 2007).

In Nigeria, most studies were conducted at urban area ground level and industries (Obioh, *et al.,* 2013; Ezeh, *et al.,* 2012; Idris, *et al.,* 2019; Jimoh & Alhassan, 2006). Thus, In this research for the first time to our knowledge, is to study and investigate the effect of altitude distribution and meteorological parameters on concentrations of PM

## THEORETICAL BACKGROUND

These equations were used to described the relationship between pressure and altitude, temperature and altitude.

### Ideal Gas Law

The atmospheric variable that determines the thermodynamic state of the atmosphere at any point are pressure, temperature and density at that point. These variables are related to one other by equation of state for an ideal gas. The equation of state is given by

$$P = \rho RT \qquad 1$$

Where p represents atmospheric pressure; ρ is density of air and is depends on altitude; T is the temperature of the air; and R is gas constant (Kato,1980)

### Hydrostatic Equation

In the absence of atmospheric motions, the hydrostatic equation express the balance between the gravitational force at any point and the vertical component of the pressure gradient force $\frac{dp}{dz}$ at that point. The hydrostatic equation may be written as

$$\frac{dP}{dz} = -\rho g \qquad 2$$

One of the most important equation in atmospheric physics is hydrostatic equation which state that the pressure decreases upward at a rate equal to the product of density and force of gravity per unit mass. (Robert & Joost, 1980)

$$dp = -\frac{P}{RT}g.dz \qquad 3$$

$$\frac{dp}{p} = -\frac{g}{RT}gdz$$

$$\int_{p_0}^{p}\frac{dp}{p} = -\int_{0}^{z}\frac{g}{RT}dz$$

$$lin\left[\frac{p}{p_0}\right] = -\int_{0}^{z}\frac{g}{RT}dz$$

Let assume that the integral is constant and we defined that integral to be the scale height.

$H = \frac{RT}{g}$ Hence;

$$p = p_0\, e^{-\frac{Z}{H}} \qquad 4$$

These equations tell us that if the mean air temperature is increase, the scale height increase and pressure drop between two fixed height level decrease (Amanda & John, 2006)

Equation (4) is known as the hypsometric equation that relates the pressure and altitude. The equation also tells us that the pressure of the atmosphere diminishes with height. Thus, in an isothermal atmosphere the pressure decreases exponentially with height by a factor of $e^{-1}$ per scale height. (Amanda & John, 2006)

In non-isothermal atmosphere, where $T = T(1 - \varepsilon_t z)$, which means the temperature decrease linearly with altitude when $\frac{dT}{dz} = -\varepsilon_t T$ where $(-\frac{dT}{dz})$ is called the temperature lapse rate. (Kato ,1980)

## MATERIALS AND METHODS

The materials used in carrying out this research are stated, and the methodology is briefly described along with a short description of the geographical area. The statistical analysis used in analyzing the data are descriptive statistics and Pearson correlation analysis using IBM SPSS version 20.

### MATERIALS

The materials used in carrying out this research include;

Particulate Matter monitor (PM Monitor), Multifunction Digital Altimeters and HP Computer

### STUDY AREA

The study area is in Kano, northern part of Nigeria. The location is situated between latitude $10^0$ 33′N and $12^0$ 23′N and longitude $7^0$ 45′E and $9^0$ 29′E (Abaje, *et.al.,* 2014). It has common boundaries to the Northeast by Jigawa State, Northwest by Katsina State, Southwest by Kaduna State, and Southeast by Bauchi State (Ezekiel, *et.al.,* 2020). The samples were collected at Dala hill. The Dala hill is located in Dala L.G.A of Kano state, Nigeria. The Dala hill stands about 534 meters (1,753 feet) high and covers a land mass of 289,892 meters. The Dala hill lies between latitude $12^0$ 00′ 30.7 ″N to $12^0$ 00 ′35.2 ″N and longitude $8^0$ 30′ 21.2″ E to $8^0$ 30′ 26.1 ″E. In the seventh century, the hill was the site of a community that engaged in iron- working (Iliffe, 2007).

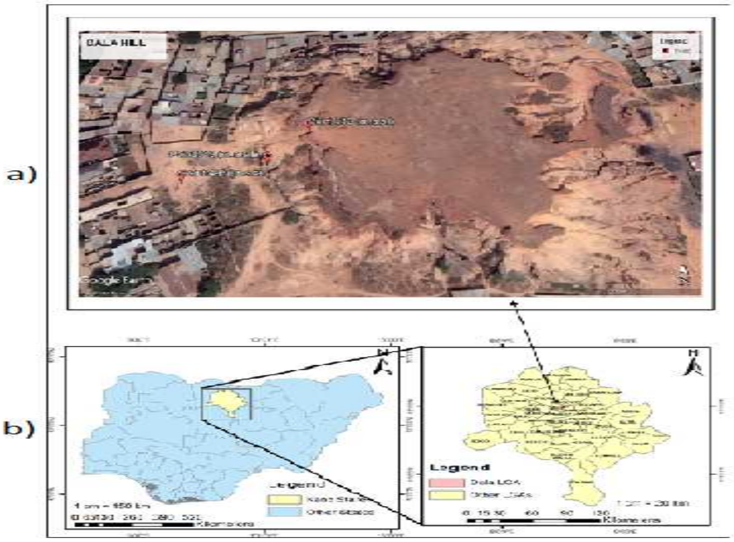

Figure1. **(a) Google Earth view of the study area with three sampling point and (b) map of the study area**

### METHOD

The data acquisition was done in urban area of Kano at Dala Hill in Dala L.G.A. The Particulate Matter concentrations, temperature and Relative Humidity were measured using handheld Particulate Matter monitor (PM monitor), while the altitude range and barometric pressure were determined using a multifunction digital altimeter. The samples were collected at three points of the hill by ascending vertically from 496 (m.a.s.l), with coordinate (12.009093, 8.505908) 519(m.a.s.l) with coordinate (12.009190, 8.506222) up to a height of a maximum of 530(m.a.s.l) with coordinate (12.009403, 8.506395). the data were recorded at five minutes interval. Then, from the observation data of PM concentration and meteorological parameters, average value were calculated for each height level. The Particulate Matter concentrations and meteorological parameters were measured three times per day: (morning, afternoon, and evening). The sampling period was between November 2020 and February 2021.

**METHOD OF DATA ANALYSIS**

The data collected during the period of study were handled and analyzed using Microsoft excel 2019 and IBM SPSS version 20 software. The software was used to perform data analysis of descriptive statistics and Pearson correlation analysis.

## RESULTS AND DISCUSSION

This section displays the results of the measurements carried out for PM concentrations and meteorological parameters at the study location.

### Vertical variation of $PM_{2.5}$ and $PM_{10}$

The vertical variation of PM for three altitudes are shown for four months in 2020 and 2021 (November and December 2020, January, and February 2021).

Figure 2a-h: **Daily variations of $PM_{2.5}$ and $PM_{10}$ concentration at 496, 519, and 530 (m.a.s.l) heights over all days of measurement during observation period (from 3rd November 2020 to 3rd February 2021)**

The daily changes of PM for the overall variation of study area are shown in the figure 3a-h above. It can be seen that the PM concentration at 496 (m.a.sl) were higher than at 519 (m.a.s.l). similarly, the concentration measured at 519 (m.a.s.l) were higher than at 530 (m.a.s.l). Generally, these clearly indicate that the PM concentrations decreases with increasing altitude (Peng, *et al.,* 2015).

Comparing the figure 2a-h with the table (3) of US National Ambient Air Quality Standards value (NAAQS) below, The NAAQS set by USEPA specify the maximum allowable concentrations for criteria air pollutants. In Nigeria, there is no standards governing air pollution emission levels. Therefore, in the absence of these standards, the data in this study is compared with NAAQS as guidelines. it can be seen that, Figure 2a, show 93% of daily average value of $PM_{2.5}$ were above (35µgm$^{-3}$) of US National Ambient Air Quality Standards at the observation altitude of 496 (m.a.s.l), 68% at the observation altitude of 519 (m.a.s.l), and 39% at 530 (m.a,s,l). These also clearly indicate that the $PM_{2.5}$ decrease with increasing altitude. Whereas the figure 2b showed that, the overall daily average values of $PM_{10}$ concentration at all observation altitude do not reach the standard limit of (150µgm$^{-3}$).

Figure 2c, showed the daily average values of $PM_{2.5}$ at the observation altitude of 496 (m.a.s.l) and 519 (m.a.s.l) are above (35µgm$^{-3}$) while 39% at the observation altitude of 530 (m.a.s.l) are above standard limit. Whereas figure 2d, showed that 19.4% of daily average value of $PM_{10}$ exceed (150µgm$^{-3}$) at the observation altitude of 496 (m.a.s.l) and 32.2% at the observation altitude of 519 (m.a.s.l) and 530 (m.a.s.l) respectively.

Figure 2e, showed the overall daily average of $PM_{2.5}$ concentrations at the observation altitude of 496 (m.a.s.l) are all above (35µgm$^{-3}$), while 68% at 519 (m.a.s.l) and 39% at 530 (m.a.s.l). Whereas figure 2f, showed that 19.4% of daily average value of $PM_{10}$ exceed (150µgm$^{-3}$) at the observation altitude of 496 (m.a.s.l) and 9.7% at 519 (m.a.s.l) and 6.5% at 530 (m.a.s.l).

Similarly, Figure 2g, showed the overall daily average of $PM_{2.5}$ concentrations at the observation altitude of 496 (m.a.s.l) are all above (35µgm$^{-3}$). And 33.3% at the observational altitude of 519 (m.a.s.l) and 530 (m.a.s.l) respectively. Whereas the overall daily average of $PM_{10}$ concentrations at all observation altitude do not reach the standard value.

**Table 1: Ambient Air Quality standard values**

| Pollutants | Average period | Standard | Unit | Sources |
|---|---|---|---|---|
| $PM_{10}$ NAAQS | 24hour | 150 | µgm$^{-3}$ | US. |
| $PM_{2.5}$ NAAQS | 24hour | 35 | µgm$^{-3}$ | US. |

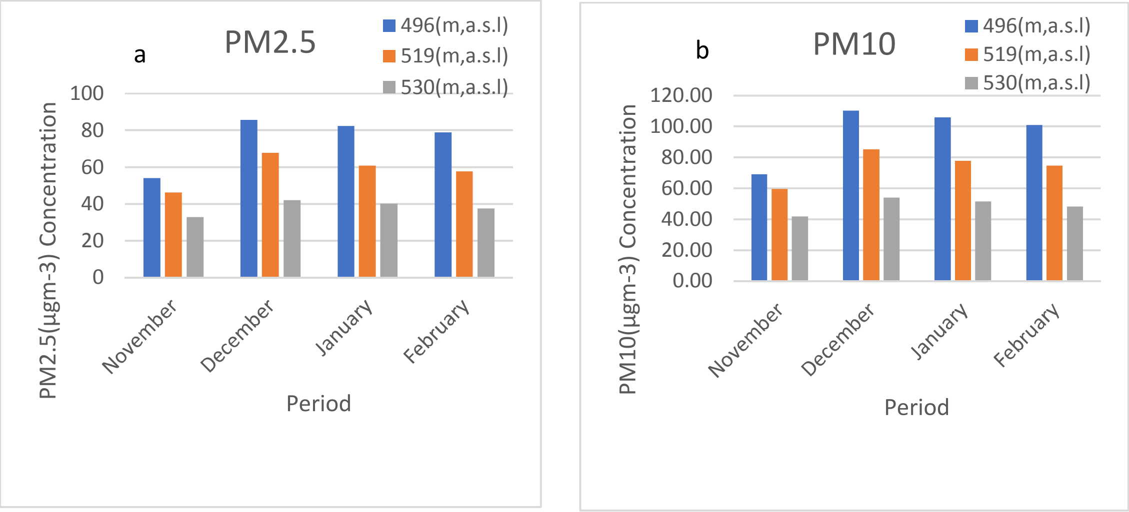

Figure 3**: Monthly variation of PM2.5 and PM10 concentrations.**

The monthly average values of $PM_{2.5}$ and $PM_{10}$ concentrations recorded from 3rd November to 3rd February are depicted graphically in the above. Generally, the figure showed that PM concentrations decreases as height increase. The vertical distribution of PM concentration in the atmosphere varies from day to night, day to day, as well as month to month. Also, from the figure above, it showed that, the concentration of $PM_{2.5}$ and $PM_{10}$ were higher in December flow by January and February and lower in November in the study area, these may attribute with many factors. Such as: Formation of fog/haze during winter season, temperature inversion: the temperature inversion is strongest in winter and weakest in summer, burning of refuse and leaves at the study area.

As shown in the figure 3a, by considering the limits given in the US. National Ambient Air Quality Standards. The monthly average of $PM_{2.5}$ are all above (35μgm$^{-3}$) except in November at the observation altitude of 530 (m.a.s.l). while figure 3b show that, the $PM_{10}$ concentrations was lower than that of the National Ambient Air Quality Standard of (150μgm$^{-3}$) in all the four months with minimum value of 41.9μgm$^{-3}$ appear in November which is far below the standard limit requirement.

**Statistical Analysis**

In order to identify the relationship between PM concentration ($PM_{2.5}$ and $PM_{10}$) and meteorological parameters, descriptive analysis and pearson correlation analysis was applied.

**Descriptive Statistics**

The descriptive statistics of observed $PM_{2.5}$ and $PM_{10}$ concentrations are summarized in Table below.

**Table 2: Summary of $PM_{2.5}$ and $PM_{10}$ Concentration Data**

| | PM2.5μgm$^{-3}$ | | | | PM10μgm$^{-3}$ | | | |
|---|---|---|---|---|---|---|---|---|
| Altitude (m.a.s.l) | Max | Min | Mean | SD | Max | Min | Mean | SD |
| 496 | 226.3 | 33.2 | 74.8 | 34 | 297.8 | 42.2 | 96 | 44 |
| 519 | 212.2 | 25.4 | 58.6 | 31.2 | 273.9 | 32.5 | 74.6 | 40.2 |
| 530 | 136.2 | 15 | 38.5 | 23.6 | 174.8 | 18.9 | 49.3 | 30.6 |

It can be seen from the table 4 that the maximum average concentration of $PM_{2.5}$ and $PM_{10}$ was found at the observational altitude of 496 (m.a.s.l) followed in decreasing order by 519 (m.a.s.l) and 530 (m.a.s.l). Another look at the table shows that, the maximum value of $PM_{2.5}$ and $PM_{10}$ concentration reach up to 226.3μgm$^{-3}$ and 297.8μgm$^{-3}$ which indicate worst air pollution occur on that particular day in the study area. This higher concentration of PM may be due to burning of refuse and leave on that particular day at the study area, formation of extreme fog, re-suspension of road dust, vehicular traffics around the study area.

Comparing table 1 with Air quality index (AQI) Standard Table (3) below. The AQI is the EPA's code for telling the public how clean or polluted the air is. The lower the value of AQI the better the air quality. The result show that the quality of $PM_{2.5}$ concentration was moderately polluted at observational altitude of 496 (m.a.s.l) (i.e.,74.8μgm$^{-3}$) and in satisfactory category at 519 (m.a.s.l) and 530 (m.a.s.l). while for the $PM_{10}$ concentration, it was found to be satisfactory category at 496 (m.a.s.l) and 519 (m.a.s.l). but at observation altitude of 530 (m.a.s.l), the pollution was within the good condition. Finally, this table also show that the PM concentration ($PM_{2.5}$ and $PM_{10}$) decrease with increasing altitude.

**Table 3: Air quality index & health effects.** (Kalia & Ansari, 2020)

| AQI Category | PM2.5 ($\mu gm^{-3}$) | PM10 ($\mu gm^{-3}$) | Health Impact |
|---|---|---|---|
| Good (0-30) | 0-30 | 0-50 | Minimal. |
| Satisfactory (51-100) | 31-60 | 51-100 | Minor Breathing discomfort to sensitive people. |
| Moderately polluted (101-200) | 61-90 | 101-250 | Breathing discomfort to asthma patents, elderly and children. |
| Poor (201-300) | 91-120 | 251-350 | Breathing discomfort to all. |
| Very poor (301-400) | 121-250 | 351-430 | Respiratory illness on prolonged exposure. |
| Severe (401-500) | 250+ | 430+ | Health impact even on light physical work, serious impact on people with heart/lung disease. |

### Pearson Correlation Analysis; Correlation between PM2.5 and PM10 Concentrations with meteorological parameters.

Pearson Correlation Coefficients(r) was carried out to analyze the nature, strength and the relationship between meteorological parameters and particulate matter (PM) concentration. Since Pearson correlation coefficient can reflect the linear correlation between two variables. Pearson correlation analysis between meteorological parameters considered in the present study (Temperature, Relative humidity, and Barometric pressure) and particulate matter concentration ($PM_{2.5}$ and $PM_{10}$) are calculated and the result are presented in the Table 4-6. The correlation were carried out at three different altitude.

Table 4 indicate that PM2.5 is significantly strongly positively correlated with PM10 (r = 0.999), weak positive correlated with barometric pressure (r = 0.172) and negative correlated with temperature (r = -0.142) and relative humidity (r = -0.04). similarly, PM10 is weak positive correlated with barometric pressure (r = 0.121) and weak negative correlated with temperature (r = -0.134) and relative humidity (r = -0.06).

Table 5 indicate that PM2.5 is significantly strongly positively correlated with PM10 (r = 0.987), weak positive correlated with barometric pressure (r = 0.162) and negative correlated with temperature (r = -0.096) and relative humidity (r = -0.13). similarly, PM10 is weak positive correlated with barometric pressure (r = 0.151) and relative humidity (r =0.26) and moderate negative correlated with temperature (r = -0.47).

Table 6 indicate that PM2.5 is significantly strongly positively correlated with PM10 (r = 1.000), weak positive correlated with barometric pressure (r = 0.118) and negative correlated with temperature (r = -0.09) and relative humidity (r = -0.46). similarly, PM10 is weak positive correlated with barometric pressure (r = 0.115) and weak negative correlated with temperature (r = -0.08) and moderate negative correlated with relative humidity (r = -0.06).

The result of the analysis indicates that, the independent variables, Temperature, relative humidity, and barometric pressure have a low correlation with PM concentrations ($PM_{2.5}$ and $PM_{10}$), but statistically strongly positive correlated was observed between PM2.5 and PM10 at all three point which indicate that increase in PM2.5 directly increases PM10 concentration. This finding is in agreement with findings of other literatures e.g. (Munir, *et al.,* 2016; Onuorah, *et al.,* 2019). It is also indicated that, the correlation between $PM_{2.5}$ concentration and meteorological parameters is higher than that of $PM_{10}$ concentrations. It can also be further observed that the magnitude of the correlation coefficients varies across different altitude. The correlation at 496 (m.a.s.l) were higher than that at 519 (m.a.s.l), similarly, the correlation at 519 (m.a.s.l) were higher than that at 530 (m.a.s.l). Generally, the Pearson correlation coefficients analysis show that $PM_{2.5}$ and $PM_{10}$ concentration are strongly negatively correlated with temperature and relative humidity (except at observational height of 519 (m.a.s.l) for relative humidity with $PM_{10}$) and positively correlated with barometric pressure. As temperature and relative humidity increases, PM concentrations ($PM_{2.5}$ and $PM_{10}$) decrease. Whereas as barometric pressure increases, PM concentrations ($PM_{2.5}$ and $PM_{10}$) also increase.

Table 4: Pearson Correlation Coefficient (r) at altitude 496(m.a.s.l)

| | PM2.5 | PM10 | Temperature | R/Humidity | B/Pressure |
|---|---|---|---|---|---|
| PM2.5 | 1 | 0.999 | -0.142 | -0.004 | 0.172 |
| PM10 | 0.999 | 1 | -0.134 | -0.006 | 0.162 |
| Temperature | -0.142 | -0.134 | 1 | -0.109 | -0.036 |
| R/Humidity | -0.004 | -0.006 | -0.109 | 1 | -0.036 |
| B/Pressure | 0.172 | 0.162 | -0.521 | -0.036 | 1 |

Table 5; Pearson Correlation Coefficient (r) at altitude 519(m.a.s.l)

| | PM2.5 | PM10 | Temperature | R/Humidity | B/Pressure |
|---|---|---|---|---|---|
| PM2.5 | 1 | 0.987 | -0.096 | -0.013 | 0.162 |
| PM10 | 0.987 | 1 | -0.047 | 0.026 | 0.151 |
| Temperature | -0.097 | -0.047 | 1 | -0.005 | -0.448 |
| R/Humidity | -0.013 | 0.026 | -0.005 | 1 | -0.045 |
| B/Pressure | 0.162 | 0.151 | -0.448 | -0.045 | 1 |

Table 6; Pearson Correlation Coefficient (r) at altitude 530(m.a.s.l)

| | PM2.5 | PM10 | Temperature | R/Humidity | B/Pressure |
|---|---|---|---|---|---|
| PM2.5 | 1 | 1.000 | -0.009 | -0.046 | 0.116 |
| PM10 | 1.000 | 1 | -0.008 | -0.045 | 0.115 |
| Temperature | -0.009 | -0.008 | 1 | 0.044 | 0.066 |
| R/Humidity | -0.046 | -0.045 | 0.044 | 1 | -0.132 |
| B/Pressure | 0.116 | 0.115 | 0.066 | -0.132 | 1 |

Table 4-6: Pearson correlation coefficient between independent and dependent variable.

## CONCLUSION

This work reports the effect of altitude and some meteorological parameters on concentration of particulate matter (PM). In conclusion the result demonstrates that the monthly average of $PM_{2.5}$ concentration for the study period exceed USEPA 24-hr standard limit ($PM_{2.5}$ =35μgm$^{-3}$) except in November at the observational height of 530 (m.a.s.l) which recorded 32.8μgm$^{-3}$. However, the $PM_{10}$ concentration for all the months were below USEPA 24-hr standard limit ($PM_{10}$ = 150μgm$^{-3}$). The over-standard limit of daily average value of $PM_{2.5}$ at the observational height of 496 (m.a.s.l), 519 (m.a.s.l), and 530 (m.a.s.l) were 96.7%, 81% and 41.3%. for the overall period of the study area. The highest number of daily averages of $PM_{10}$ concentration for the overall study period were below standard limit except 13% at the observational height of 419 (m.a.s.l) 4.3% at 519(m.a.s.l) and 3.3% at 530 (m.a.s.l). This showed that, the $PM_{2.5}$ concentration was highest at the study area. The role of meteorological parameters has been analyses and the study also concludes that the relationship between PM concentration and meteorological parameters influence the pollutant concentration. From the correlation analysis PM concentration showed negatively correlation with temperature and relative humidity (as temperature and relative humidity increase the PM concentration decrease, while as barometric pressure increase the PM concentration also increase).

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