DUST FALL MONITORING IN UNIVERSITY OF IBADAN, UNIVERSITY OF ILORIN AND KWARA STATE UNIVERSITY MOTOR PARKS, NIGERIA

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ABSTRACT

The study was carried out for five months from November, 2014 to April, 2015 during which dust fall (particulate matter) was monitored in University of Ilorin, University of Ibadan and Kwara State University motor parks. Dust fall monitoring was carried out using Single open bucket sampler based on American Standard Test Method (ASTM D1739). The average dust fall depositions were found to be 1122.15 ± 50, 627.648 ± 34, and 316.322 ± 16 $mgm^{-2}day^{-1}$ for University of Ilorin (Un), Kwara State University (Kw) and University of Ibadan (UI) sites respectively. It was observed that unpaved surface and number of moving vehicles were the main factors for increased or decreased in dust fall concentrations. There was correlation between some meteorological parameters (rain fall, wind speed, temperature and relative humidity) and dust fall depending on the site.

Keywords: Dust fall; Motor Park; Traffic counting; Correlation;

1. INTRODUCTION

Urban are characterized with dense population and traffic together with industrial activities. Therefore, they are exposed to high levels of contamination and in sequence hazardous effects. Awareness and control of air pollution in these locations is very important, Malakootian *et al*., (2013). Transport, particularly, road transports are associated with the hazards to the environment and human health , Dora and Philips, (2000). The atmospheric dust loading has been increasing over the last years due to global warming, increasing desertification and human activities, Derbyshire, (2007). Health problems linked to atmospheric dust range from minor eye irritation to upper respiratory symptoms, chronic respiratory diseases, such as, asthma, cardiovascular diseases and lung cancer. Environmental effects of dust include the influence on biogeochemical cycles of the earth, influence on earth's radiation balance and influence on atmospheric chemistry, Malakootian *et al*., (2013).

The objectives of the study were; to monitor dust fall in University of Ibadan, University of Ilorin and Kwara State University motor parks and also to correlate the dusts fall with meteorological parameters (rain fall, temperature, wind speed and relative humidity) and also with number of moving vehicles.

2. EXPERIMENTAL METHODOLOGY

2.1 LOCATION OF SAMPLING STATION

Three monitoring stations; University of Ilorin, Kwara Sate University and University of Ibadan motor parks were chosen for the study. Both University of Ilorin and Kwara State University are located in Kwara State, Nigeria and it lies on longitude 8°30´N and latitude 4°40´E. University of Ibadan is located in Ibadan metropolis, Oyo State, Nigeria and it lies on longitude 7°22´N and latitude 3°58´E.

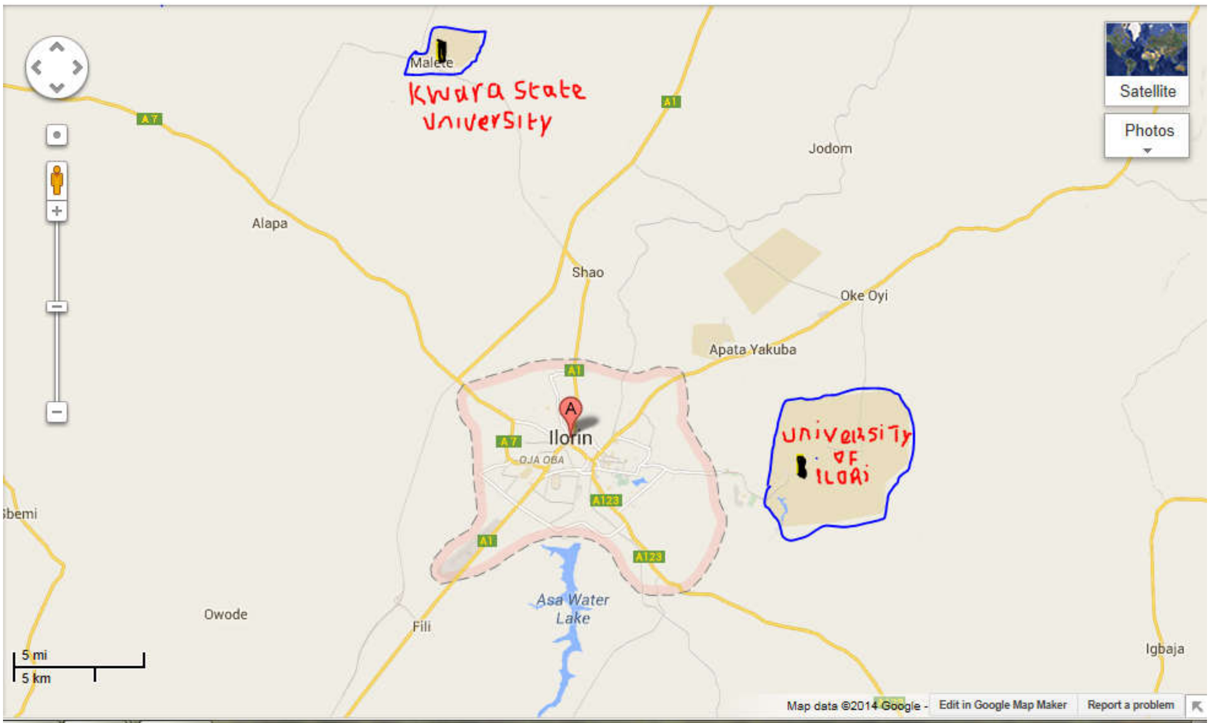

Figure 1: Street map of Ilorin showing University of Ilorin and Kwara State University

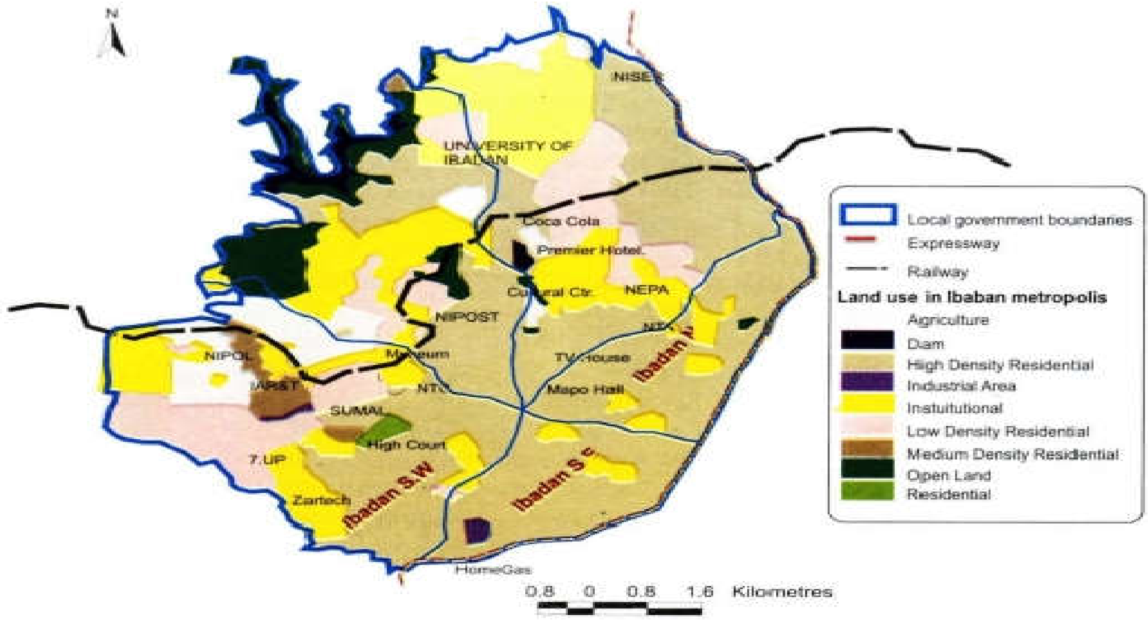

Figure 2: Map of Ibadan metropolis indicating University of Ibadan

2.2 DUST FALL COLLECTION AND ANALYSIS

The samples were collected for five months from November, 2014 to March, 2015. Meteorological data for University of Ibadan was obtained from International Institute of Tropical Agriculture (IITA), Oyo State, Nigeria. Whereas the meteorological data for University of Ilorin and Kwara State University was collected from Department of Physics, university of Ilorin. For this research ambient dust (particulate matter) was collected using single open bucket sampler in which the mass concentration of the particulate matter (settle dust) is given in $mgm^{-2}day^{-1}$ unit. Single open bucket sampler is based on the American Standard Test Method (ASTM) D1739 of 1998 (2010) and was shown in Figure 3. The bucket was placed on a stand comprising of a ring supported by four stabilizing bars above the base plate. This serves to prevent contamination of the sample by perching birds. A net insect screen was also placed over the bucket opening to prevent insects from contaminating the sample. The base plate was connected to a 2 m long steel pole which was buried to a depth of approximately 0.5 m. The method did not have a wind shield around the bucket so that both course and fine precipitating dust samples could be collected irrespective of the wind situation. Settling dust material was collected in 20 L cylindrical plastic buckets half filled with distilled water. The height (h), radius (r) and the area (A) of the bucket (bottom) are 0.342 m, 0.138 m and 0.059836248 m^2 respectively. Exposed buckets was replaced after 30 days of sampling period and transported to the laboratory for further treatment and analysis. Water – dust sample mixtures was filtered through pre-weighed 0.47 mm Whatmann filter papers using filtration under low pressure. The samples were air dried in partially open petri dishes in a "dust free laboratory". After drying, gravimetric analysis was conducted to determine the insoluble fraction based on the following equations:

Calculation of the dust deposition rate:

$Cu = Mf - Mb/AT$ ……………………………..(1)

Where Cu = dust deposition rate ($mgm^{-2} day^{-1}$)

Mf = Weight of loaded filter (mg)

Mb = Weight of blank filter (mg)

A = Area of the bucket (m^2)

T = Sample duration (days)

Figure 3: Single open bucket sampler (ASTM D1739, 2010)

2.3 TRAFFIC COUNTING

A traffic count is a count of traffic along a particular road, either done electronically or by people counting by the side of the road. Traffic counts can be used by local councils to identify which routes are used most, and to either improve that road or provide an alternative if there is an excessive amount of traffic. The length of the sampling period depends on the type of count being taken and the intended use of the data recorded. For example, an intersection count may be conducted during the peak flow period. If so, manual count with 15-minute intervals could be used to obtain the traffic volume data. The count period should be representative of the time of day, day of month, and month of year for the study area. Count periods may range from 5 minutes to 1 year. Typical count periods are 15 minutes or 2 hours for peak periods, 4 hours for morning and afternoon peaks, 6 hours for morning, midday, and afternoon peaks, and 12 hours for daytime periods [Robertson, 1994]. Thus, the vehicles passing along the selected roads were counted for 12 peak hours from 8 am to 8 pm for three consecutive days of every month and average was taken from 10 busiest roads of the Quetta for the period of two years; 2010 and 2011, Khan *et al*, (2013). The vehicles passing along the selected roads were counted for 12 peak hours from 8 am to 8 pm for three consecutive days of every month and average was taken from busiest roads while buses, trucks, wagons, cars, motorbikes and rickshaws were counted separately, Hamidullah *et al*., (1998).

Therefore for this study, the vehicles passing (entering) the selected motor parks were counted for 12 peak hours from 6 am to 6 pm for three consecutive days of every month and average was taken.

2.4 STATISTICAL ANALYSIS

Mean values and standard deviation were calculated using Microsoft excel. The relationship between two variables (Dust and meteorological parameters; rain fall, temperature, wind speed and relative humidity) was obtained using correlation coefficient and linear relationship (scattered plot). The Pearson correlation and linear relationship (scattered plot) analysis were carried out in SPPSS.

3. RESULTS DISCUSSION

The average Dust fall for Un at the month of November, December, 2014 and January, February, and March, 2015 were found to be 1119.37, 1044.19, 1517.55, 980.14 and 949.15 $mgm^{-2}day^{-1}$ respectively. The lowest Dust fall, 949.15 $mgm^{-2}day^{-1}$ was obtained in the month of March, 2015 while the highest Dust fall was obtained in the month of January, 2015 as in in Table 1 and Figure 11. The increased in the amount of monthly average dust fall for the month of January was due to increased number of vehicle that entered the motor park which was about 500 from 6 am to 6 pm in a day. Similar observation were reported by Khan *et al.,* (2013), Khan *et al.,* (2002), Malokootia *et al.,* (2013), Tyagi *et al.*, (2014), Norela *et al.,* (2009), Beg *et al.*, (1987). It was also observed that rainfall increases in the months of February and March which suppressed the blowing of the dust and hence the reason for low dust mass deposition in the month of February (980.14 $mgm^{-2}day^{-1}$) and March (949.15 $mgm^{-2}day^{-1}$).

The average Dust fall for Kw at the month of November, December, 2014 and January, February, and March, 2015 were found to be 442.74, 150.36, 598.67, 1211.36 and 735.11 $mgm^{-2}day^{-1}$ respectively. The lowest Dust fall, 949.15 $mgm^{-2}day^{-1}$ was obtained in the month of December, 2014 while the highest Dust fall was obtained in the month of February, 2015 as shown in Table 1 and Figure 4. The increased in the dust fall for the monthly February was due to windstorm that blew more dust particles into the sampler. Also the increased in the amount of monthly average dust fall was due to increased number of vehicle that entered the motor park which was about 167 from 6 am to 6 pm in a day. The lowest Dust fall in the month of December was due decreased in the number of vehicle which was 33 during holyday for three weeks. Similar observation were reported by Khan *et al,* (2013), Khan *et al,* (2002), Malokootia *et al.,* (2013), Tyagi *et al.*, (2014), Norela *et al.,* (2009), and Beg *et al.*, (1991).

The average Dust fall for UI at the month of November, December, 2014 and January, February, and March, 2015 were found to be 214.41, 97.46, 320.22, 785.23, and 164.29 $mgm^{-2}day^{-1}$ respectively. The lowest Dust fall, 97.46 $mgm^{-2}day^{-1}$ was obtained in the month of December, 2014 while the highest Dust fall, 785.23 $mgm^{-2}day^{-1}$ was obtained in the month of February, 2015 as shown in Table 1 and Figure 4. In the month of February, it was a period for flowering of a tree in that motor park. Therefore, the dust fall amount was remarkably increased due contribution from pollen grain which is also particulate matter. Also the increased in the amount of monthly average dust fall was due to increased number of vehicle that entered the motor park which was about 533 from 6 am to 6 pm in a day. The lowest Dust fall in the month of December was due decreased in the number of vehicle which was 67 during holyday for three weeks. Similar observation were reported, Khan *et al.,* (2013), Malokootia *et al.,* (2013), Tyagi *et al.*, (2014), Norela *et al.,* (2009) and Beg *et al.*, (1991).

Table 1 shows the average Dust fall for all the study sites while Figure 5 indicates their variations. Among all the study sites of the current study, the highest average Dust fall with the value of 1122.15 $mgm^{-2}day^{-1}$ was experienced with University of Ilorin (Un). It was followed by Kwara State University (Kw) whose average site Dust fall was found to be 627.648 $mgm^{-2}day^{-1}$ while that of University of Ibadan was found to be 316.322 $mgm^{-2}day^{-1}$. The Dust fall at Un was 3.55 times more than that of UI and about 1.78 times more than that of Kw. High Dust fall deposition at Un and Kw were due to the fact that both sites were unpaved during the monitoring programme and hence when vehicle entered those motor parks, dusts are are blown off and the blowing depends on the speed of the vehicle. Therefore, the more speed on the unpaved surface, the more dusts are blown off and reversed is case when the speed is low. The above facts can be supported by findings of Mnisi and Moja, (2013) which stated that the uncovered earth surface of a sampling site increases its dust mass concentration which was 2009 $mgm^{-2}day^{-1}$. And the concentration of 2009 $mgm^{-2}day^{-1}$ found in unpaved surface by Mnisi and Moja, (2013) was found to be higher than the unpaved surface at Un (1122..15 $mgm^{-2}day^{-1}$) and Kw (627.648 $mgm^{-2}day^{-1}$) of the current study. The values of dust fall obtained exceed the permissible limit of 133 $mgm^{-2}day^{-1}$ of the Department of Envionment (DOE, 1996), Malaysia. However, South African permissible dust limit for residential and light commercial of 600 $mgm^{-2}day^{-1}$ was exceeded at University of Ilorin and Kwara State University but University fell below. Therefore such high concentrations of the dust fall can various health problems especially to those that visit the motor parks regularly.

Though the dust concentration in this study was found to be high, another study by Khan *et a.l*, 2013, was higher. They reported the level of dust fall in Quetta, Pakistan in the year 2010 and 2011 which obtained the average value of 38670 and 42020 $mgm^{-2}day^{-1}$ respectively. The concentration of dust fall in Kerman City, Iran was obtained at the range of 6560 to 24420 $mgm^{-2}day^{-1}$, Malakootian *et al.*, (2013). These values are higher than the one obtained in the current study sites. Another study carried out in four seasons at Vanderbijlpark, South Africa by Mnisi and Moja, (2013) reported average mass concentrations that ranged from 242 – 1270 $mgm^{-2}day^{-1}$ in autumn (March) which exceed the current study sites in the month of March which were 949.51 $mgm^{-2}day^{-1}$ for University of Ilorin, 735.11 $mgm^{-2}day^{-1}$ for for Kwara State University and 164.29 $mgm^{-2}day^{-1}$ for University of Ibadan. But for the values of 156-846 $mgm^{-2}day^{-1}$ in summer (December) were higher than 150.36 $mgm^{-2}day^{-1}$ for for Kwara State University and 97.46 $mgm^{-2}day^{-1}$ for University of Ibadan while lower than 1044.19 $mgm^{-2}day^{-1}$ for University of Ilorin. Another study carried out in residential area of the Nilai Industrial Park in Negeri Sembilian, Malaysia, obtained the concentration of dust deposition to be 253.9 $mgm^{-2}day^{-1}$, Norela *et al.*, (2009).

Table 1 : Dust deposition ($mgm^{-2}day^{-1}$)

Months/sites	University of Ilorin		Kwara State University		University of Ibadan	
	Dust fall	Traffic Count	Dust fall	Traffic Count	Dust fall	Traffic Count
November, 2014	1119.37±71	333	442.74±4	83	214.41±4	267
December, 2014	1044.19±59	317	150.36±8	33	97.46±4	67
January, 2015	1517.55±51	500	598.67±4	100	320.22±20	333
February, 2015	980.14±71	200	1211.36±82	167	785.23±47	533
March, 2015	949.51±35	150	735.11±24	133	164.29±4	167
Average	**1122.152±230**		**627.648±392**		**316.322±274**	

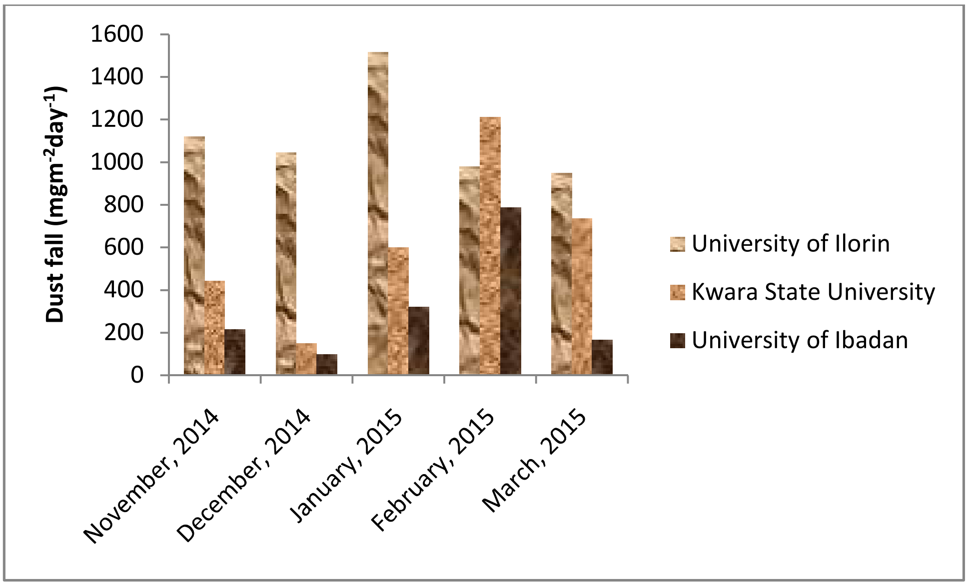

Figure 4 : Average monthly variation of dust fall at three sites

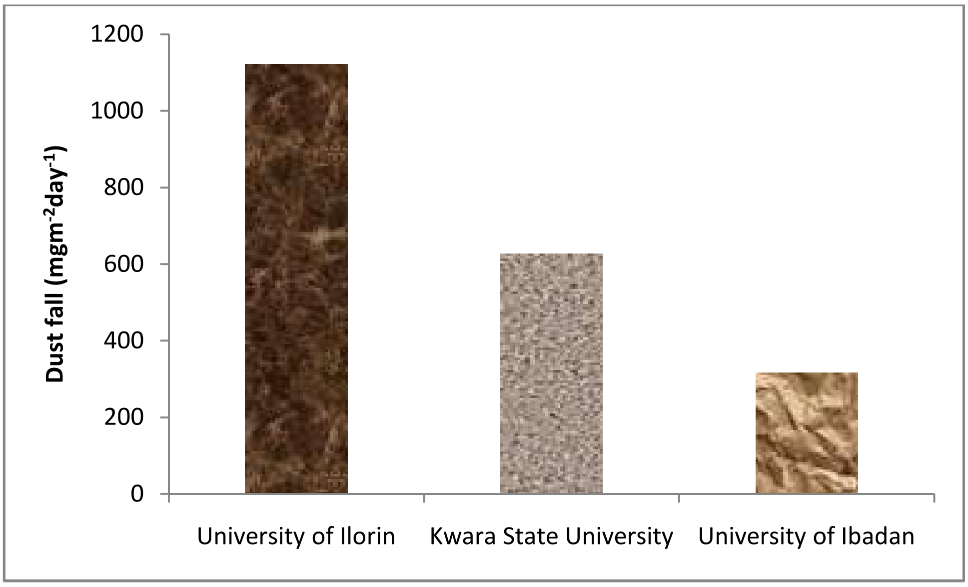

Figure 5 : Average dust fall at three sites

CORRELATION BETWEEN METEOROLOGICAL DATA, NUMBER OF VEHICLES AND DUST FALL

The person correlation analysis and scattered plot were used to analyse the relationships between the monthly averages Dust fall deposited with the number of vehicle and the meteorological parameters at each site. The meteorological data for University of Ilorin (Un) and Kwara State University (Kw) sites was collected from Weather Station in Physics Department of University of Ilorin whereas for the University of Ibadan (UI) site was collected from international Institute of Tropical Agriculture (IITA), Ibadan. The five months data collected from November, 2014 to March, 2015 included temperature, wind speed, relative humidity, and Rain fall. Table 2 and 3 shows the monthly average weather data from International Institute of Tropical Agriculture, Weather Station, Nigeria and monthly average weather data from Department of Physics, University of Ilorin respectively.

Table 2: Monthly average weather data from International Institute of Tropical Agriculture, Weather Station, Nigeria

Month	Rainfall (mm)	Wind Speed ($kmhr^{-1}$)	Minimum Temperature (° C)	Maximum Temperature (° C)	Minimum Relative Humidity (%)	Maximum Relative Humidity (%)
2015						
January	0.00	4.3	19.6	33.2	25	75
February	37.95	4.8	24.0	34.6	34	87
March	62.90	4.8	24.2	35.0	32	84
2014						
November	49.10	3.1	22.8	31.4	50	90
December	0.00	3.2	21.5	32.5	30	86

Table 3 : Monthly average weather data from physics department, University of Ilorin

Month	Rainfall (mm)	Wind Speed ($kmhr^{-1}$)	Minimum Temperature **(° C)**	Maximum Temperature **(° C)**	Minimum Relative Humidity **(%)**	Maximum Relative Humidity **(%)**
2015						
January	2.09	2.1	29.6	29.8	68	68
February	3.60	2.0	29.7	29.8	40	40
March	3.85	2.4	30.6	31.3	40	69
2014						
November	0	1.95	24.9	29.5	77	78
December	0	1.10	28.0	28.1	50	50

Pearson correlation coefficient between the number of vehicle and the dust fall is shown in table 4. This correlation coefficient of 0.940, 0.977 and 0.948 for university of Ilorin, Kwara State University and University of Ibadan indicates strong positive correlation between the number of vehicle and the dust fall. These means as number of vehicle increases, the dust fall also increases and conversely.

Table 4 : Pearson correlation coefficient between the number of vehicle and the dust fall

	University of Ilorin, Dust fall	Kwara State University, Dust fall	University of Ibadan, Dust fall
Traffic Count	0.940	0.977	0.948

Several meteorological parameters were analyzed to see if a correlation exists between them and the amount of dust fall collected. Thus, Pearson correlation was used to analyse the relationship between the Dust fall and the meteorological parameters at each sites. To show the correlation results apparently, the Dust fall was plotted against each meteorological parameter. Both Pearson correlation and scattered plot shows the same correlation results. For University of Ilorin (Un) site, correlation coefficient between the Dust fall and meteorological parameters is shown in Table 5. Therefore, there was no correlation between rain fall, wind speed, temperature and Dust fall due to nearly zero correlation coefficient while weak positive correlation occurred between relative humidity and Dust fall as shown in Table 5 and scattered plot; Figures 6, 7, 8 and 9 respectively. Lack of correlation between rain fall, wind speed, temperature and Dust fall due to nearly zero correlation coefficient indicates that decrease or increase in each of them does not affect one another. Whereas the weak positive correlation between relative humidity and Dust fall indicates that as Dust fall increases, the relative humidity increases.

Table 5: Pearson Correlation Coefficient between Dust Fall Concentration and Meteorological Parameters at Un

Meteorological Parameters	Dust fall at Un
Rain fall	-0.203
Wind speed	0.091
Temperature	-0.056
Relative humidity	0.457

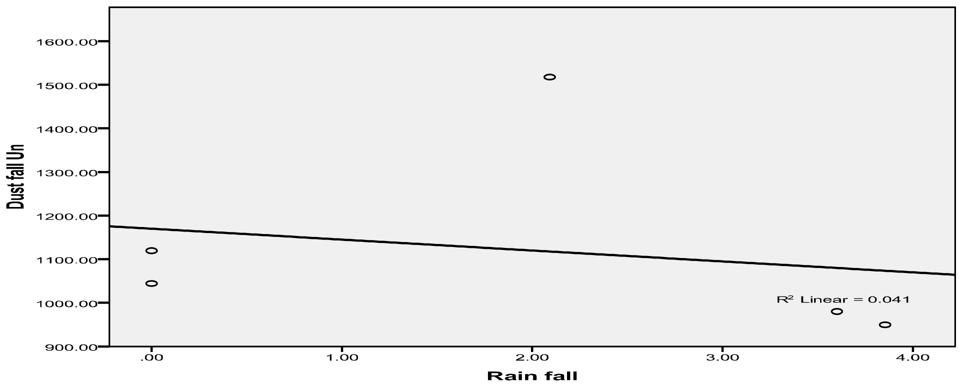

Figure 6: Correlation between Dust Fall Concentration and Rain at Un

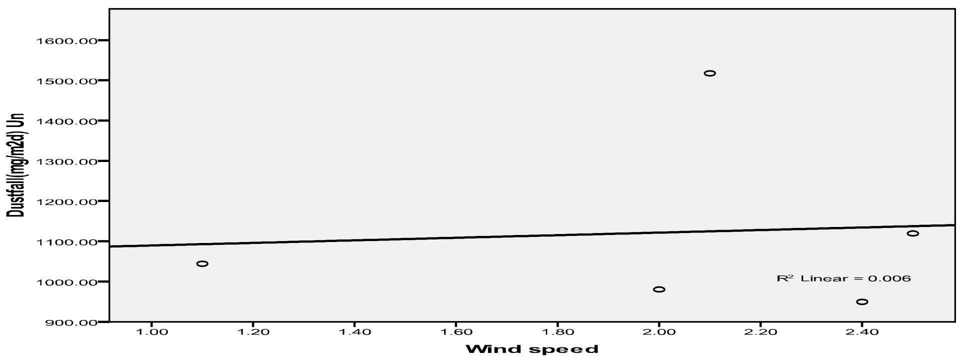

Figure 7: Correlation between Dust Fall Concentration and Wind Speed at Un

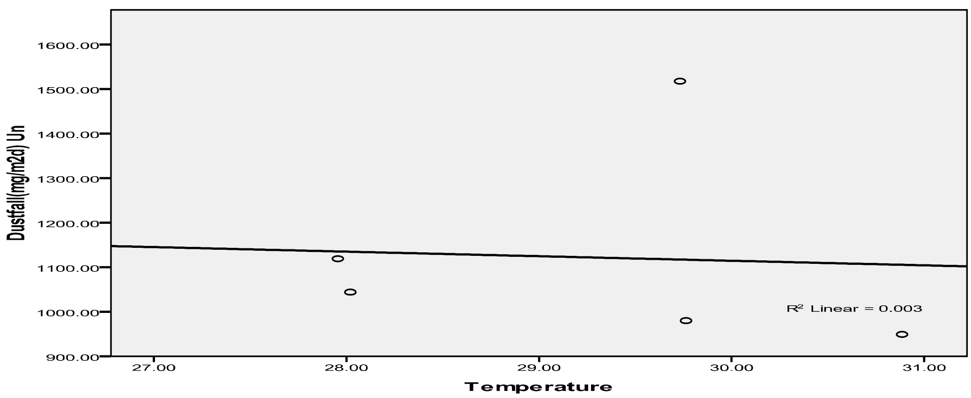

Figure 8: Correlation between Dust Fall Concentration and Temperature at Un

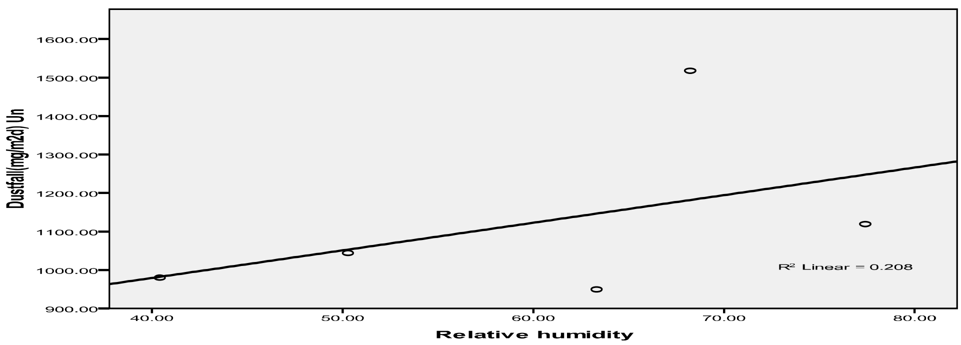

Figure 9: Correlation between Dust Fall Concentration and Relative humidity at Un

For Kwara State University (Kw) site, correlation coefficient between the Dust fall and meteorological parameters is shown in Table 6. The correlation coefficient between the rain fall and Dust fall, Table 6 and the scattered plot, Figure 10 indicates that there was strong positive correlation. Also, moderate positive correlation exists between wind speed, Temperature and Dust fall as in Table 4 and scattered plot, Figures 11 and 12. These positive correlation means as the rain fall, wind speed and temperature increase, the Dust fall increases. However, weak negative correlation exists between relative humidity and Dust fall as in Table 6 and scattered plot, Figure 13. This means that as the relative humidity increases, the Dust fall increases and conversely.

Table 6: Pearson Correlation Coefficient between Dust Fall Concentration and Meteorological Parameters at Kw

Meteorological Parameters	Dust fall at Kw
Rain fall	0.838
Wind speed	0.629
Temperature	0.651
Relative humidity	0.430

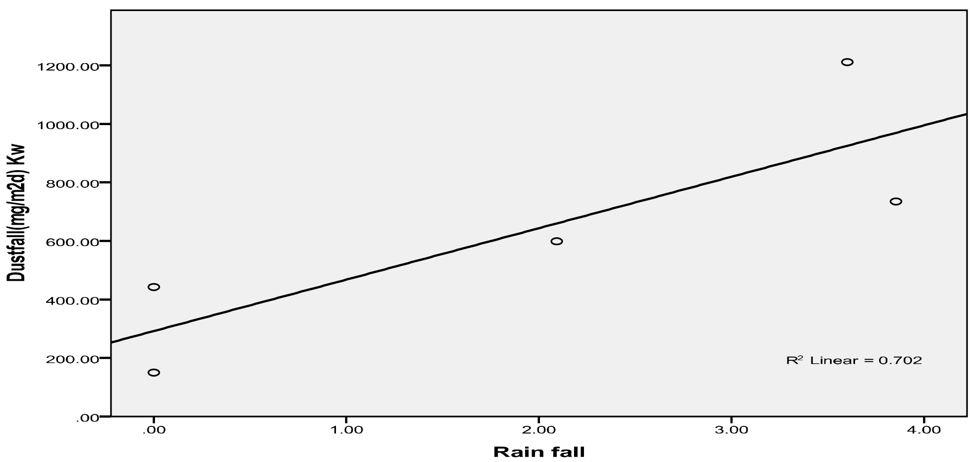

Figure 10: Correlation between Dust Fall Concentration and Rain at Kw

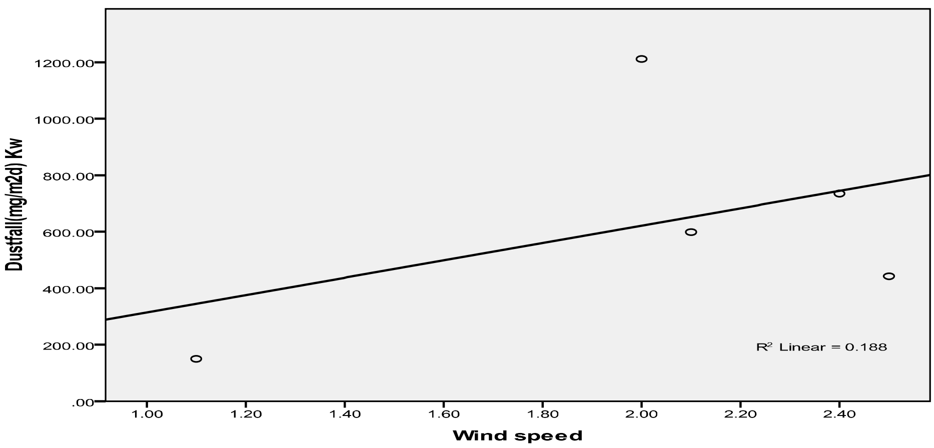

Figure 11: Correlation between Dust Fall Concentration and Wind Speed at Kw

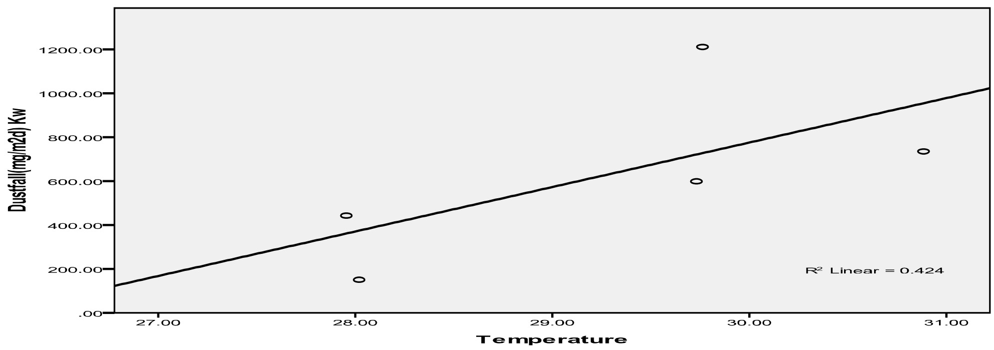

Figure 12: Correlation between Dust Fall Concentration and Temperature at Kw

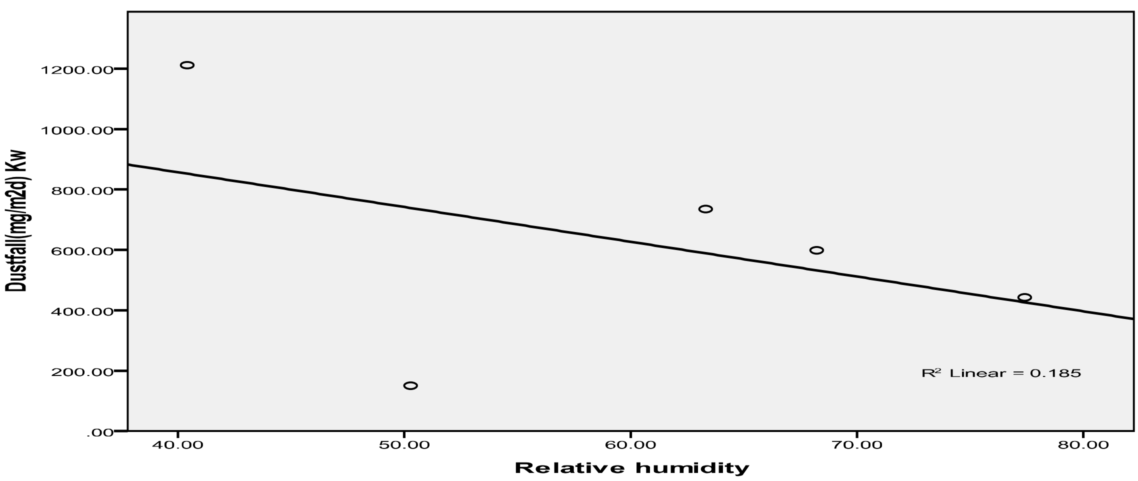

Figure 13: Correlation between Dust Fall Concentration and Relative humidity at Kw

For University of Ibadan (UI) site, correlation coefficient between the Dust fall and meteorological parameters is shown in Table 7. There were no correlations between rain fall, relative humidity and Dust fall as in Table 7and scattered plot, Figures 14 and 17. Lack of correlation between rain fall, relative humidity and Dust fall due to nearly zero correlation coefficient indicates that decrease or increase in each of them does not affects one another. But moderate and weak positive correlation exists between wind speed, temperature and Dust fall respectively as shown in Table 7 and scattered plot, Figures 15 and 16. This means that as the wind speed and temperature increases, the Dust fall also increases.

Table 7: Pearson Correlation Coefficient between Dust Fall Concentration and Meteorological Parameters at UI

Meteorological Parameters	Dust fall at UI
Rain fall	0.097
Wind speed	0.567
Temperature	0.441
Relative humidity	0.052

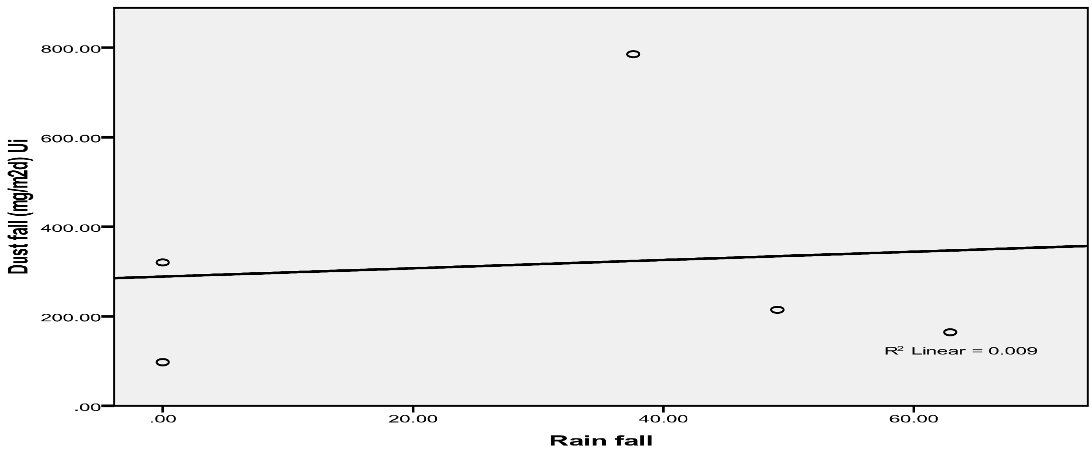

Figure 14: Correlation between Dust Fall Concentration and Rain at UI

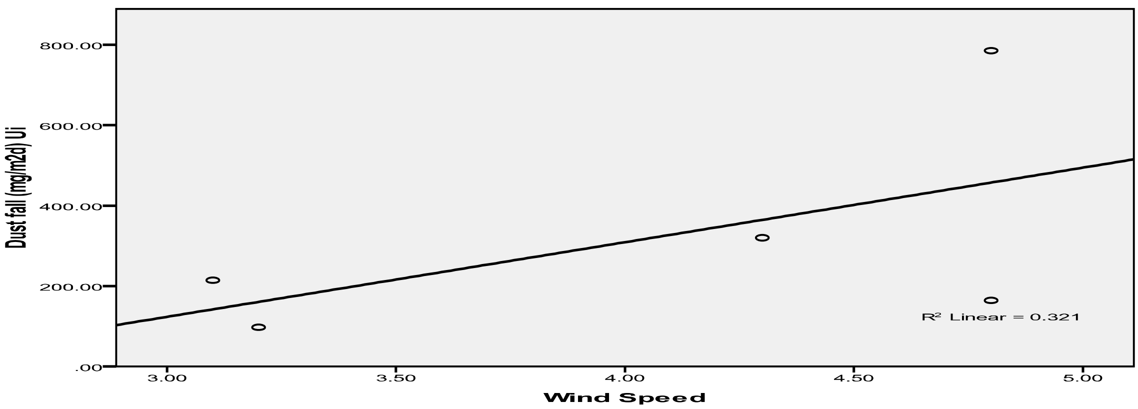

Figure 15: Correlation between Dust Fall Concentration and Wind Speed at UI

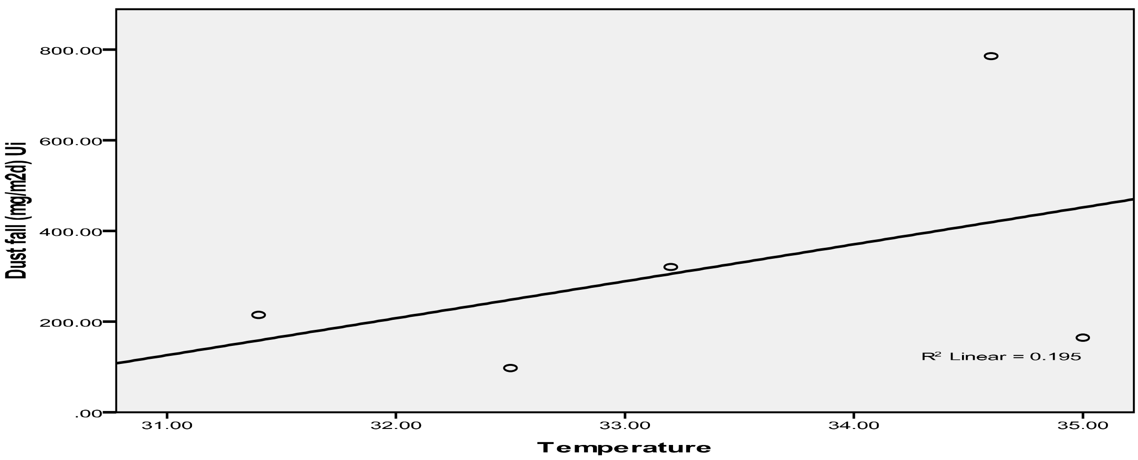

Figure 16: Correlation between Dust Fall Concentration and Temperature at UI

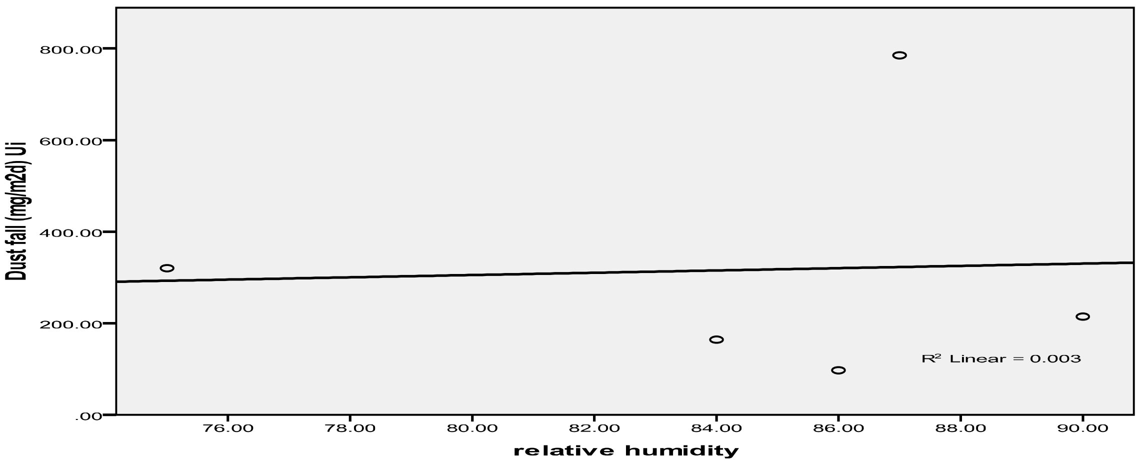

Figure 17: Correlation between Dust Fall Concentration and Relative humidity at UI

CONCLUSION

The concentrations of the dust fall in all the study sites were found to be higher especially when compared with permissible limit of 133 $mgm^{-2}day^{-1}$ by (DOE, 1996). It was observed that unpaved surface and number of vehicles were the main factors for increased or decreased in dust fall concentrations. That is, the more unpaved, the surface, the higher, the dust fall and conversely while the higher, the number of moving vehicles, the higher, the dust fall. There was no significant correlation between the dust fall and meteorological parameters in all the study sites. In Kwara State University, there was correlation between the dust fall and the meteorological parameters. Whereas for University of Ibadan, correlation exists between wind speed, temperature and the dust fall but no correlation between rain fall, relative humidity. However, for University of Ilorin no correlation exists between rain fall, wind speed, temperature and the dust fall but weak correlation occurred between relative humidity and the dust fall.

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