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MONITORING AND EVALUATION OF AIR QUALITY IN THE UNIVERSITY OF CROSS RIVER STATE (UNICROSS) WORK ENVIRONMENT USING PM2.5 AS INDICATOR

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Abstract

A study to investigate ambient air quality at the university of Cross River State has been carried. Air pollution has recently been reported by the World health organization as the second leading cause of death through exacerbation of several respiratory and cardiovascular diseases. The objectives of this study are to investigate the level of air pollution in the various work environments at the University of Cross River State, UNICROSS Calabar Campus. Air quality monitoring was undertaken at designated locations such as: office spaces, laboratory halls and lecture halls in other to determine the exposure level of staff to pollution and suggest possible mitigation strategies or control measures to ameliorate its impacts. Using $PM_{2.5}$ as indicator, the study finds that the concentration of $PM_{2.5}$ in the various locations selected for the study show elevated values above WHO limits. That there is generally a high concentration of $PM_{2.5}$ during the morning hours which decreases as the day ages only. It is also observed that the administrative block located near the university gate has the highest average values. This could be attributed to higher vehicular activities where wait, drop and pick activities occur during work days. Elevated values at the laboratories and Workshops areas can be attributed to activities related to the use of chemicals, metals and production works in these areas. Air quality values are relatively lower in other locations which house classrooms and staff offices. Incidentally all the values in all the locations are far above WHO recommended safe limits which portends a dangerous trend for students and university workers in general. It is advised health safety measures including adequate ventilations be used as first aid measure to avoid a build-up of these pollutants to avoid associated health consequences.

Key words: Monitoring and Evaluation, $PM_{2.5}$ Pollutants, Work Environment, Unicross

1.0 Introduction

The interaction between man and his environment has been a subject of intense study. The facts remain that both the biotic and abiotic environments must co-exist in a balance. The introduction of unwanted substances into the environment often alter that balance and hurts the ecosystem (1, 2).

Of all three types of environmental pollution namely water, air and land, air pollution is by far the most complex, widespread and most hazardous. While polluted water can be purified or avoided, air pollution defies any form of purification. The concentration of these pollutants and exposure levels differ from one environment to the other. Indoor environments differ from outdoor environments in that they limit diffusion which increases with wind speed and air circulation. Laboratory and office environments are a special type of indoor environments characterised by the presence of chemicals, office furniture, paper, excrements of reptiles, rodents and other forms of biotic lives.

In a study in Europe by (3), it was discovered that, in 2019 alone, air pollution was the main cause of disability-adjusted life years lost (DALYs). Another study found out that life expectancy was reduced by about one year due to exposure to $PM_{2.5}$ alone (4).

Nature provides that the environment which is the interaction between the living (biotic) and the non-living (abiotic) should co-exist in a balance in the ecosystem. When that balance is altered, the health of both components is put at risk. This often happens when pollutants are introduced into the ecosystem (1, 2). Many pollutants are toxic substances which not only destroy the comfort and functionality of the ecosystem, but are hazardous to all living organisms.

Due to the global surge of air pollution and its attendant environmental and health hazards, many countries including the United Nations, have put in place specialized agencies dedicated to air quality. Unfortunately, the situation is different in developing countries where the burden of disease due to air pollution is even higher. Rather, issues relating to air pollution are directed to environmental protection agencies, which are often saddled with several other weighty duties.

As a result of increasing morbidity and mortality, following increasing exposure to air pollution has been identified as the second leading risk factor for death worldwide by the World Health Organization. Reported figures of the UNEP, updated in 2023, show that anthropogenic air pollution is on top of the list of leading public health hazards worldwide, accounting for about 9 million deaths per year. It also reports that about 3.8 billion people are exposed to indoor air pollution. That ninety-nine percent of the world population breathe air that is above WHO limits. No people or nation is therefore immune from its impacts. Air pollution is not only ubiquitous, but because air circulates around the globe, it is transboundary. Unfortunately, air pollution is yet to be declared a global emergency.

Loss of life expectancy indicated by untimely death is becoming a cause for concern in Nigeria. In UNICROSS, the sudden and untimely demise of staff has been on increase in recent times. There is ample evidence in literature that shows that the work-environment contributes significantly to the overall quality of air people breathe. We also find that air pollution is responsible for most

respiratory and cardiovascular diseases resulting in heart attack, liver enlargement, increasing hospitalization and sudden collapse and death, especially in Middle- and low-income countries (MLIC).

Air pollution has been identified as the second leading risk factor for death worldwide by the World Health Organization. About 49% of the people are exposed to indoor air pollution above recommended WHO standard resulting in about 9 million deaths annually.

The quality of our health depends, in most part, on the quality of what we ingest namely, air, water and food. Of the three, air is the most important and the most neglected with serious attendant health consequences. Unarguably, air remains one of the first and most important requirement of life.

Air pollution has been found to exert disastrous consequences on the environment and the climate system resulting in climate change, hospitalizations and various fatalities (5,6). Climate change and air pollution are twin brothers threatening food security and human and animal survival. (7, 8). Air pollution is ubiquitous. Through diffusion and wind circulation, air pollutants are distributed all over the globe – both on land and sea. Saharan dust from Africa, for instance, has been identified in faraway United States, significantly affecting Puerto Rico, the U.S. Virgin Islands, and southern continental states including Florida and Texas (9).

There are various health effects arising from exposure to high doses of air pollution. The effects are generally grouped into two categories namely: short-term and long-term effects.

Short-term effects have to do with lighter symptoms such as such as eyes, nose, skin and throat irritation, breathing difficulties, wheezing and coughing are others. In the other hand, symptoms such as heart, liver and lung complications, bronchitis, asthma and pneumonia are more serious ailments arising from short-term exposure.

The long-term effects are those ones can are more severe symptoms such as cardiovascular diseases, heart attack, chronic asthma, etc. Even diabetes has been isolated in a Swedish cohort study to be exacerbated by prolong exposure (10). Perinatal disorders often link to infant mortality (7) while Mental disorders have been linked to and chronic disease in the later years of lfe (11).

World health organization and other reports have raised alarm over the risk of air pollution resulting in increased in morbidity and mortality rates(12). Some studies have observed adverse cardiovascular disorders due to exposure to air pollutants (13) including changes in blood cells and coronary arteriosclerosis (14). Other symptoms such as Ventricle hypertrophy and Neurological effects have been reported due to prolonged exposure to Nitrogen Oxide (NO_2) (15, 16).

More complicated ailments such as autism, low birth weight and retinopathy have also been linked to long-term exposure to air pollution (17). Oxidative stress, inflammation and mitochondrial impairment have equally been linked to exposure to air pollution (18) (see figure1 below).

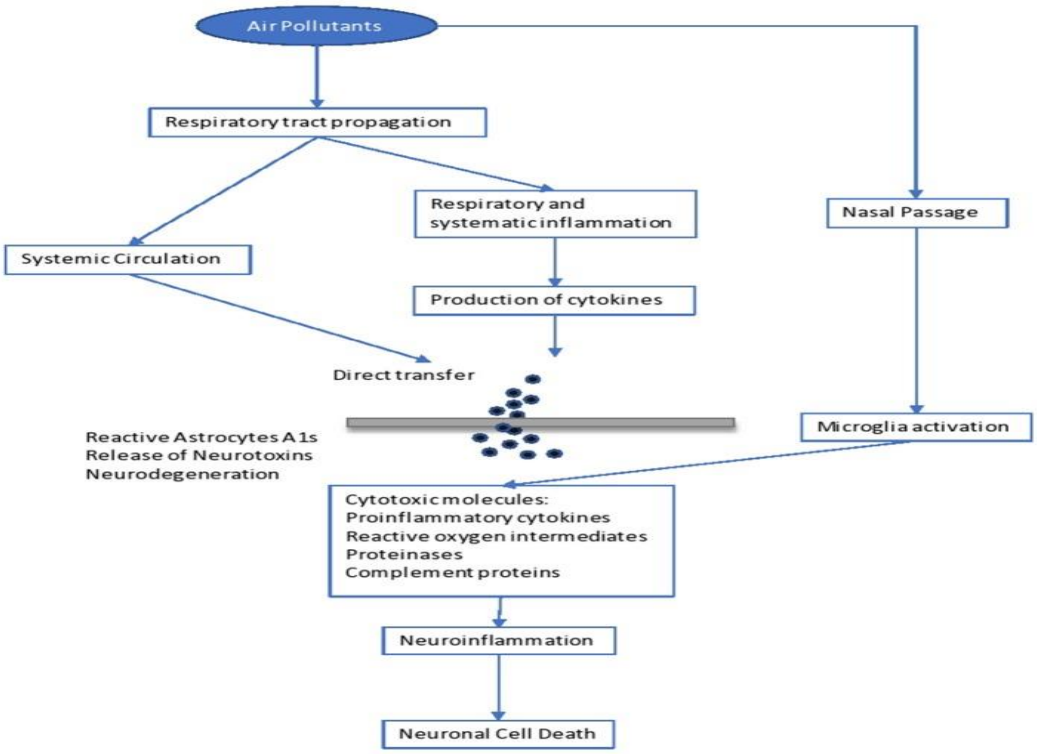


Fig. 1: Impact of air pollutant on the brain

In a study when dogs were exposed to high doses of air pollutants brain inflammation was observed and markers of systemic inflammation were observed in humans showing that inflammation comes as a secondary effect of oxidative stress (19, 20, 21).

All around the world, air pollution is dealing a strong blow on humanity, as a result of increase in anthropogenic activities such as industrialisation, urbanisation and complex mix of poor housing poor ventilation. Available literature shows very few air quality studies over Africa and yet most of these studies indicate that PM levels exceed WHO limits in most cities. Available ground based studies are often of a short duration. In spite of all these, international interventions are few. Most projects have either been stalled or discontinued. In most of the studies carried out, data collection was done for a duration of less than a year and some less than 24 h per day. (22, 23, 24).

A strong indicator of Loss of life expectancy is untimely death. The sudden demise of staff long before retirement in Nigeria and UNICROSS, in particular, has become a cause for concern in recent times. Hence, the need for this study on the monitoring and evaluation of air quality in the work-environment.

3.0 Materials and Methods

3.1 Materials

Materials used for the study included Atmotube Mobile Air particle sampler and analytical tools

3.2 Methods

The study area was divided into:

1. Laboratory environment
2. Classroom environment
3. Office environment

The Mobile Air particle sampler was deployed to capture in-situ data in the various work environments. The monitoring processes were repeated over a four months period such that two months fell within (July and August) the wet season and two months in the dry season (November and December).

3.3 Data analyses: The data collected was screened for data integrity, consistency and filtered before being subjected to analyses. The Statistical package for Social Sciences, SPSS was used for the analyses.

3.4 WHO air quality safe limits

Table 1: New WHO guidelines for air pollutants. Adapted from

Pollutant		Time	2005 levels	New 2021 levels
$PM_{2.5}$	Particulate matter <2,5 microns	Annual	10	5
		24-hour	25	15
PM_{10}	Particulate matter <10 microns	Annual	20	15
		24-hour	50	45
O_3	Ozone	Peak season	-	60
		8-hour	100	100
NO_2	Nitrogen dioxide	Annual	40	10
		24-hour	-	25
SO_2	Sulfur dioxide	24-hour	20	40
CO	Carbon monoxide	24-hour	-	4

Source: World Health Organisation (24)

4.0 Results

4.1 Analyses of $PM_{2.5}$

$PM_{2.5}$ is the major indicator used for the assessment of air quality globally. The reason is that is the most prevalent of all the air pollutants which exerts serious consequences on human health. It has to do with all particulates below 2.5 micrometers in diameter. The concetration of $PM_{2.5}$ is often measured in microgram per meter cubic ($\mu g/m^3$). Such microscopic particles have the ability to penetrate the air tracks through the tiny spaces of the lungs deep into the blood stream. Because they are not biodegradable, they cannot be eliminated from the body. Instead, they are transported into all organs of the body. where they can be deposited in the tiny blood vessels or. There can be deposited in any part of the respiratory track, blood vessels or vital organs of the body, causing

obstruction to blood flow, resulting in liver enlargement, heart and kidney failure among many other ailments.

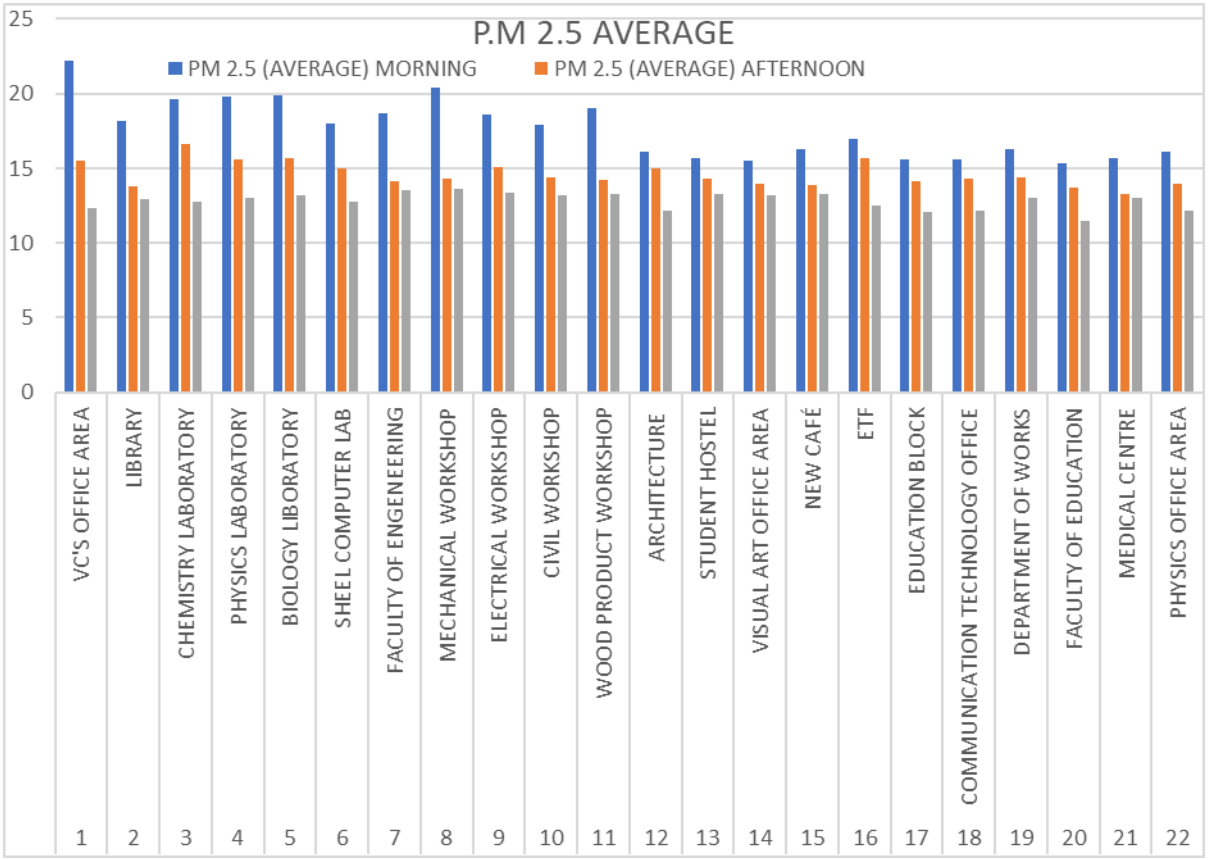


Fig. 2 Average concentration values of $PM_{2.5}$

Figure 1 is a graph of the concertation of $PM_{2.5}$ in the various locations chosen for the study. It shows that there is a high concentration of $PM_{2.5}$ during the morning hours which decreases as the day goes by. It is also observed that locations 1 which houses the administrative block has the highest average values. It is observed that it is closest to the school gate where a lot of vehicular activities such as wait, drop and happens during work days. Locations 3-11 house booth laboratories and Workshops where chemicals and metals and production activities are carried out. Air quality values are relatively lower in other locations which house classrooms and staff offices. Incidentally all the values in all the locations are far above WHO recommended safe limits as shown in figure 1.

In respect to these picked out locations, it is advised to ensure all health safety measures and also ensure adequate ventilations to avoid a build-up of these particulate matter in these locations and other locations.

From figure 1 we can notice that there is a continues fall in the concentration of P.M 2.5 as the ages. They are obviously due to a decrease in the aforementioned activies from morning to evening when work closes.

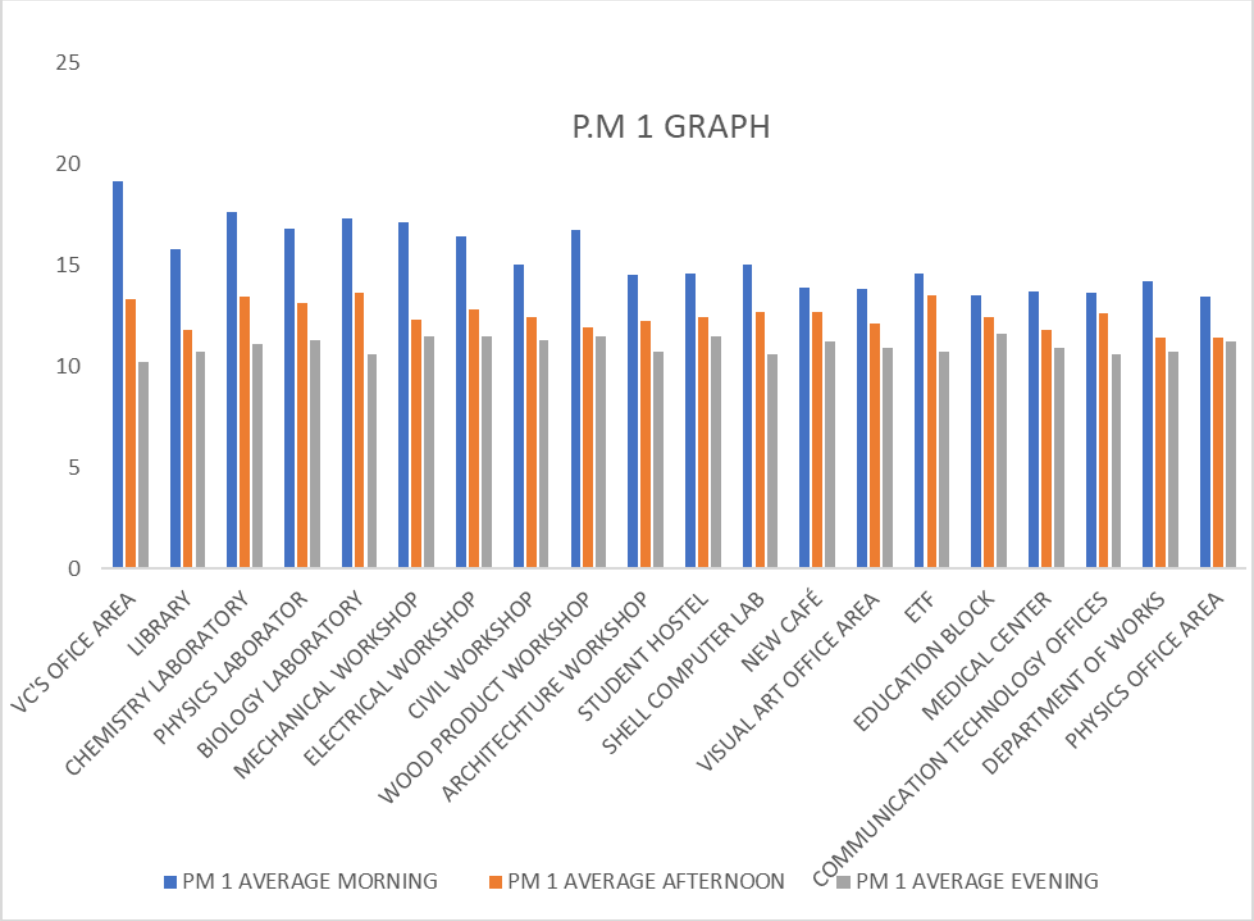
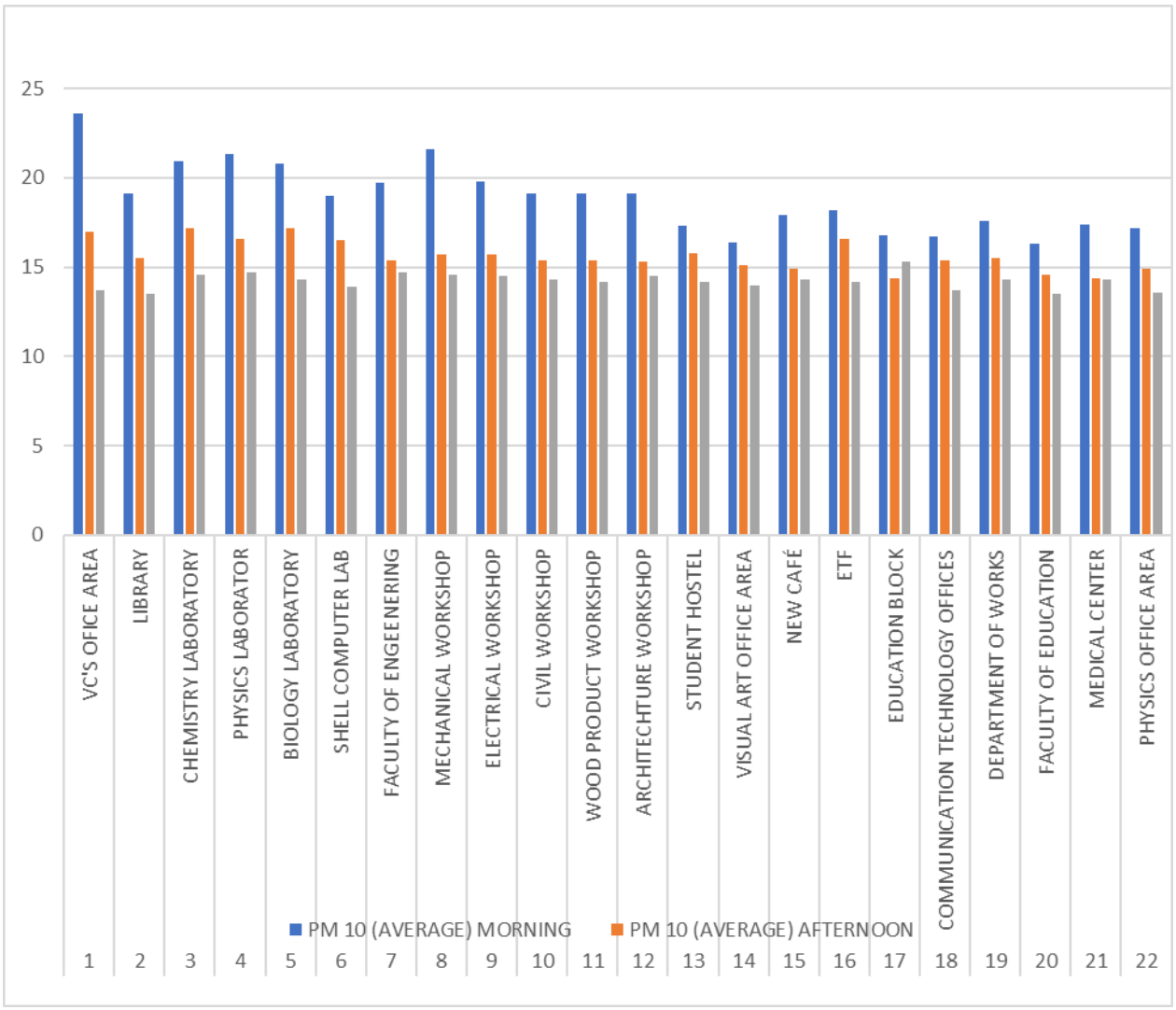


Fig 3. Graph of the concentration of PM1.

The concentration of PM_1 follows the same trend as $PM_{2.5}$. This is not surprising as the concentration of PM_1 is captured by $PM_{2.5}$ as shown in figure 2.



As expected, the concentration of PM10 follows a similar trend. Though PM10 is not as hazardous as PM_1 and $PM_{2.5}$. the concentration can be seen as a control to ascertain the veracity of the trends indicated by the other two particulates from morning to evening.

Generally, it is evident that there is a high presence of particulate matter in the school environment during the morning hours compared to the afternoon and evening hours which conforms with the period of a beehive of activities in the university environment.

Conclusion

We can conclude that both vehicular activies and laboratories activities are responsible for elevated values of air pollution in the University work environment.

There is observed a high concentration of $PM_{2.5}$ during the morning hours which decreases as the day ages only. It is also observed that the administrative block located near the university gate has the highest average values. This could be attributed to higher vehicular activities where wait, drop and pick activities occur during work days. Elevated values at the laboratories and

Workshops areas can be attributed to activities related to the use of chemicals, metals and production works in these areas. Air quality values are relatively lower in other locations which house classrooms and staff offices. Incidentally all the values in all the locations are far above WHO recommended safe limits which portends a dangerous trend for students and university workers in general. Because particulate matter is not biodegradable, it cannot be eliminated from the body, but are transported and deposited in the respiratory tracks, blood vessels or vital organs of the body, causing obstruction to blood flow, resulting in liver enlargement, heart and kidney failure among many other ailments. As a preliminary measure it is advised that health safety measures including adequate ventilations be used as first aid to avoid a build-up of these pollutants to avoid associated health consequences. Further and in-depth monitoring and evaluation particulate matter, including other forms of pollutants be included in the study. Other forms of gas and particle analysers should also form part of the instrumentation.

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