Particulate Matter (PM-10) Levels in Ambient Air of University of Yangon

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Abstract: *This study was carried out to measure the concentrations of air pollutants (PM-10) in ambient air of the University of Yangon (UY) campus, which is located adjacent to the 3 junctions such as Hledan junction, University Avenue road junction and Innya road junction. The PM-10 samples were collected from 9 different sites in UY campus during July to December, 2018. The content of some heavy metals (Cd, Cu, Pb and Mn) in PM-10 samples were quantitatively determined by AAS technique. The concentrations of PM-10 in cold season were found to be higher than those in rainy season. PM-10 levels of UY-6 and UY-9 were found to be highest in all samples. But PM-10 levels of all samples (except UY-9 in cold season) were observed within the permissible level of (OSHA, 2017) standard. According to AAS data, the concentrations of heavy metals (Cd, Cu, Pb and Mn) in PM-10 samples for rainy and cold seasons were not exceeding the Occupational Safety and Health Administration (OSHA, 2017) and National Institute of Occupational Safety and Health (NIOSH, 2017) standard. According to the standard air quality index, the air quality conditions of PM-10 of University of Yangon is good air quality in rainy season and moderate air quality in cold season. The results of this study identified the degree of air quality of University of Yangon.*

Key Words: *PM-10, ambient air, air quality index, AAS, OSHA, NIOSH.*

1.   INTRODUCTION:

The present-day atmosphere is quite different from the natural atmosphere that existed before the Industrial Revolution in terms of chemical composition. If the natural atmosphere is considered to be 'clean', then this means that clean air cannot be found anywhere in today's atmosphere. Therefore, particulate air pollution (PAP) has become a matter of global concern, particularly in some of the world's largest cities (Uno *et al.,* 2013). With the rapid growth of urban population, number of vehicles and industries within Yangon Region has increased. Consequently, enhancing air-pollution might become an issue in the near future and threats of the residents. There may be potential hazards in the near future unless initiates preventive measures from now on. Therefore, it is necessary to monitor to what extent the environment is polluted or to assess to what extent the public is concerned about the issue. This study will give more information about air quality in University of Yangon and its effects on public health.

2. MATERIALS AND METHODS:

Samples are airborne particulate matter (PM-10) samples and often called inhalable particles. The fabricated air sampling pump (High Volume Air Sampler) was used to collect PM-10 samples. The air sampler was placed about 3 m above the ground. All the   PM-10 samples were collected on glass microfiber filter with diameter of 37 mm and pore size of 1.0 µm. Automatic air flow meter was set at a nominal flow rate of 2 Lm^{-1}. Temperature and pressure were also simultaneous measured hourly during the sampling period. The PM-10 samples were collected for 8 hours from 8:00 am to 4:00 pm during the period of July to August, 2018 representing rainy season and November to December, 2018 representing cold season. Some heavy metal contents in PM-10 samples were determined by Atomic Absorption Spectrophotometric method.

3. RESULTES AND DISCUSSION:

The PM-10 samples were collected from University of Yangon in rainy and cold season, 2018. The mean concentrations of PM-10 in rainy and cold seasons were 2.0697 and 4.0920 mg m^{-3} respectively. The minimum and maximum concentrations of PM-10 in rainy season were 0.8333 and 3.1250 mg m^{-3} respectively and in cold season were 2.5926 and 6.0417 mg m^{-3} respectively. The concentrations of PM-10 in cold season were found to be higher than rainy season. The high concentrations of PM-10 in rainy season and cold season were found in UY-6 (3.1250 and 4.5833 mg m^{-3}) and UY-9 (2.7083 and 6.0417 mg m^{-3}) respectively as shown in Table 1 and Figure 1.

The UY-6 and UY-9 samples were collected from science canteen and Taungoo canteen and it was found that charcoal and gas stove were used for cooking. Moreover many photocopier shops are situated in science canteen. The UY-1, UY-3, UY-4 and UY-7 samples are collected from Convocation Hall, Recreation Centre, Universities' Central Library and Shwe Bo Hall respectively. These buildings are public areas and hostel. Therefore concentrations of PM-10 in those buildings were found to be higher than the lecture building. The concentrations of PM-10 in all samples (except UY-9 in cold season) were found to be within the (OSHA, 2017) air quality guideline.

Some heavy metals (Cd, Cu, Pb and Mn) contents in   PM-10 samples collected from 9 sampling sites of UY campus in rainy and cold seasons respectively were shown in Tables 2-6 and Figures 2-5. Generally, Cd, Cu, Pb and Mn contents in all PM-10 samples in cold season were found to be relatively higher than those in rainy season. This is probably due to the fact that the cold season is convenient for travelling, so traffic density is more increased in cold season. Moreover, building and road construction activities are more increased in cold season than those in rainy season. In rainy season, pollutants get washed and settle down on the earth due to the heavy rainfall and attributed by the wind. Therefore the quality of ambient air is good in rainy seasons than those in cold season. But heavy metals (Cd, Cu, Pb and Mn) contents in all PM-10 samples for both seasons were found to be very small amount and within the permissible level of OSHA (2017) and NIOSH (2017) standard.   Air quality index values are related to corresponding health impacts of pollutants. Great value of index reflects high concentration of air pollutants and adverse impact of human health.

According to the standard air quality index, ambient air of University of Yangon is good air quality in rainy season and moderate air quality in cold season (Table 6). Good (green) means satisfactory air quality and moderate (yellow) means acceptable air quality.

Table 1. Concentrations of PM-10 Samples Collected From University of Yangon in Rainy and Cold Seasons, 2018

Sr No.	Sample	Sampling Site	Concentration of PM-10 (mg m^{-3})	
			Rainy	Cold
1.	UY-1	Convocation Hall	2.5000	3.9583
2.	UY-2	Science Hall	1.7708	3.8542
3.	UY-3	Recreation Centre	2.2917	4.3750
4.	UY-4	Universities' Central Library	1.4583	2.5926
5.	UY-5	Innwa Hall	0.8333	4.2708
6.	UY-6	Science Canteen	3.1250	4.5833
7.	UY-7	Shwe Bo Hall	2.2917	4.0150
8.	UY-8	Taungoo Hall	1.6484	3.4375
9.	UY-9	Taungoo Canteen	2.7083	6.0417
		Average	2.0697	4.0920
		Minimum	0.8333	2.5926
		Maximum	3.1250	6.0417

OSHA Standard Value (2017) – 5.00 mg m^{-3}

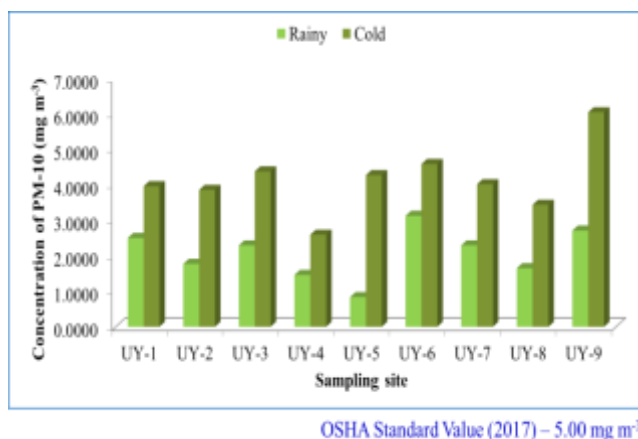OSHA Standard Value (2017) – 5.00 mg m^{-3}

Figure 1. Histogram of concentrations of PM-10 samples collected from University of Yangon in rainy and cold seasons, 2018

Comparison of concentrations of Cd in PM-10 samples
Table 2 and Figure 2 showed the comparison of concentrations of Cd in PM-10 samples. The mean concentrations of Cd in PM-10 samples in rainy season and cold season were 0.0002 and 0.0085 mg m^{-3}. The minimum and maximum concentrations of Cd in rainy and cold season were 0.0001 and 0.0009 mg m^{-3} and 0.0042 and 0.0150 mg m^{-3} respectively. It was found that the concentrations of Cd were decreased in rainy season but its concentration was below the allowable limit of 0.02 mg m^{-3}. Cd levels in exhaust emissions have connected to the composition of gasoline, motor oil and car tires.

Comparison of concentrations of Cu in PM-10 samples
Table 3 and Figure 3 showed the comparison of concentrations of Cu in PM-10 samples. The mean concentrations of Cu in PM-10 samples in rainy season and cold season were 0.0002 and 0.0019 mg m^{-3}. The minimum and maximum concentrations of Cu in rainy and cold season were 0.0001 and 0.0007 mg m^{-3} and 0.0003 and 0.0034 mg m^{-3} respectively. It was found that the concentrations of Cu were decreased in rainy season but its concentration was below the allowable limit of 1.0 mg m^{-3}. Copper is derived from brake and clutch abrasion and corrosion of radiator.

Comparison of concentrations of Pb in PM-10 samples
Table 4 and Figure 4 showed the comparison of concentrations of Pb in PM-10 samples. The mean concentrations of Pb in PM-10 samples in rainy season and cold season were 0.0004 and 0.0016 mg m^{-3}. The minimum

and maximum concentrations of Cu in rainy and cold season were 0.0001 and 0.0005 mg m^{-3} and 0.0009 and 0.0048 mg m^{-3} respectively. It was found that the concentrations of Pb were decreased in rainy season but its concentration was below the allowable limit of < 1.0 mg m^{-3}. It may be directly related to the use of leaded gasoline discharged into the environment by automobile exhaust and waste of batteries.

Comparison of concentrations of Mn in PM-10 samples

Table 5 and Figure 5 showed the comparison of concentrations of Mn in cold season were 0.0004 and 0.0026 mg m^{-3}. The minimum and maximum concentrations of Mn in rainy and cold season were 0.0001 and 0.0011 mg m^{-3} and 0.0007 and 0.0074 mg m^{-3} respectively. It was found that the concentrations of Mn were decreased in rainy season but its concentration was below the allowable limit of 1.0 mg m^{-3}. Mn are used in alloys and steel.

Table 2.   Comparison of Concentrations of Cd in PM-10 Samples

Sr No.	Sampling Site	Concentration of Cd (mg m^{-3}) in PM-10 Samples	
		Rainy	Cold
1.	UY-1	0.0002	0.0089
2.	UY-2	0.0002	0.0075
3.	UY-3	0.0001	0.0085
4.	UY-4	0.0009	0.0114
5.	UY-5	0.0001	0.0067
6.	UY-6	0.0002	0.0051
7.	UY-7	0.0002	0.0094
8.	UY-8	0.0001	0.0042
9.	UY-9	0.0001	0.0150
	Average	0.0002	0.0085
	Minimum	0.0001	0.0042
	Maximum	0.0009	0.0150
	OSHA Standard Value (Zixus, 2017) – 0.02 mg m^{-3}		

OSHA*- Occupational Safety and Health
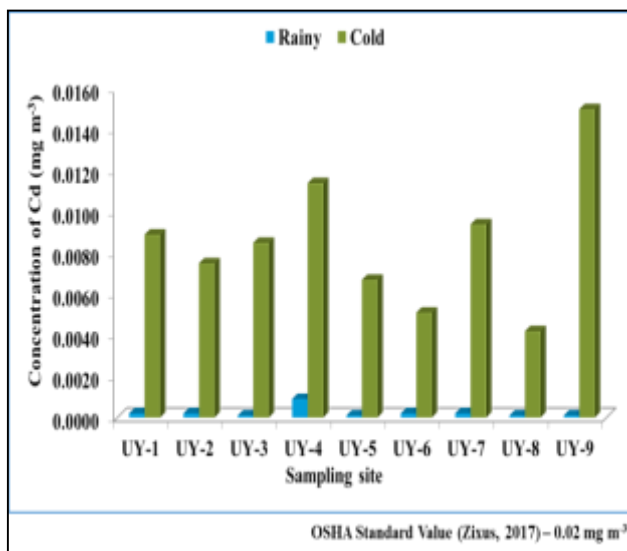   Administration (Zixus, 2017)

Figure 2.   Histogram of Cd concentrations in PM-10 samples

Table 3.   Comparison of Concentrations of Cu in PM-10 Samples

Sr No.	Sampling Site	Concentration of Cu (mg m^{-3}) in PM-10 Samples	
		Rainy	Cold
1.	UY-1	0.0003	0.0009
2.	UY-2	0.0002	0.0007
3.	UY-3	0.0003	0.0026
4.	UY-4	0.0003	0.0014
5.	UY-5	0.0001	0.0034
6.	UY-6	0.0002	0.0022
7.	UY-7	0.0002	0.0011
8.	UY-8	0.0003	0.0030
9.	UY-9	0.0002	0.0016
	Average	0.0002	0.0019
	Minimum	0.0001	0.0007
	Maximum	0.0003	0.0034
	NIOSH Standard Value (Zixus, 2017) – 1.0 mg m^{-3}		

NIOSH - National Institute of Occupational Safety
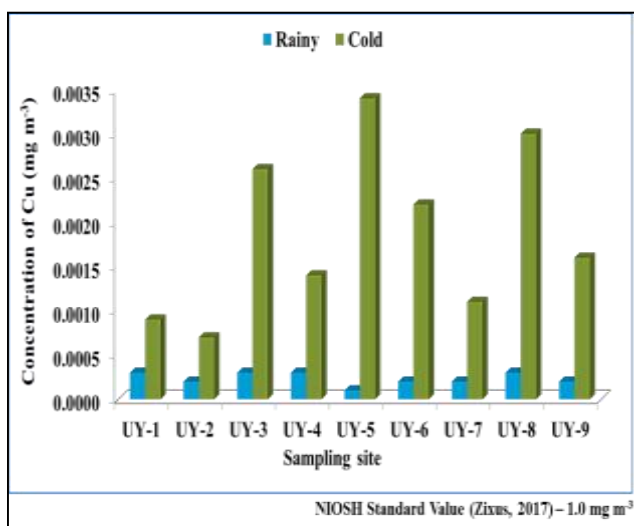   and Health (Zixus, 2017)

Figure 3.   Histogram of Cu concentrations in PM-10 samples

Table 4.   Comparison of Concentrations of Pb in PM-10 Samples

Sr No.	Sampling Site	Concentration of Pb (mg m⁻³) in PM-10 Samples	
		Rainy	Cold
1.	UY-1	0.0007	0.0013
2.	UY-2	0.0002	0.0005
3.	UY-3	0.0003	0.0006
4.	UY-4	0.0005	0.0006
5.	UY-5	0.0002	0.0005
6.	UY-6	0.0004	0.0048
7.	UY-7	0.0009	0.0011
8.	UY-8	0.0004	0.0030
9.	UY-9	0.0001	0.0006
	Average	0.0004	0.0016
	Minimum	0.0001	0.0005
	Maximum	0.0009	0.0048
	NIOSH Standard Value (Zixus, 2017) – <1.0 mg m⁻³		

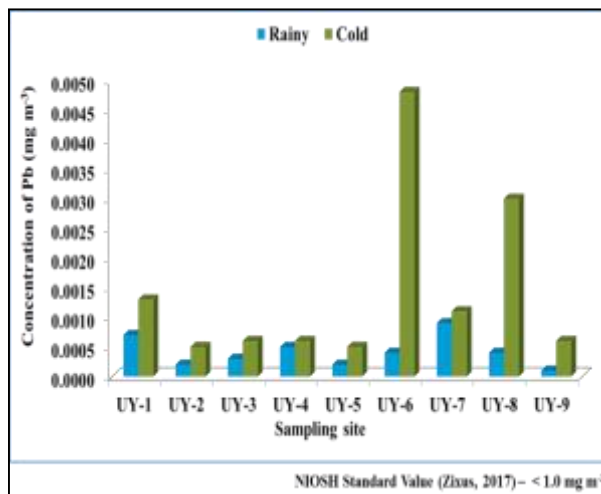NIOSH - National Institute of Occupational Safety and Health (Zixus, 2017)

Table 5.   Comparison of Concentrations of Mn in PM-10 Samples

Sr No.	Sampling Site	Concentration of Mn (mg m⁻³) in PM-10 Samples	
		Rainy	Cold
1.	UY-1	0.0005	0.0026
2.	UY-2	0.0004	0.0015
3.	UY-3	0.0004	0.0014
4.	UY-4	0.0007	0.0030
5.	UY-5	0.0003	0.0011
6.	UY-6	0.0002	0.0022
7.	UY-7	0.0003	0.0074
8.	UY-8	0.0004	0.0022
9.	UY-9	0.0001	0.0024
	Average	0.0004	0.0026
	Minimum	0.0001	0.0011
	Maximum	0.0007	0.0074
	OSHA Standard Value (Zixus, 2017) – 1.0 mg m⁻³		

NIOSH-   National Institute of Occupational Safety

Figure 4. Histogram of Pb concentrations in PM-10 samples
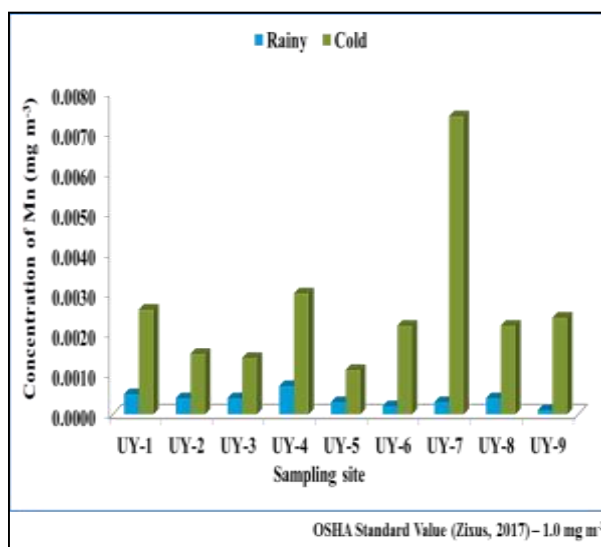

Figure 5. Histogram of Mn concentrations in PM-10 samples

Table 6.   Air Quality Index of University of Yangon

Sr No	Season	Air Quality Index Value of UY	Standard Air Quality Index Value	Air Quality Condition	Symbolized Color
1.	Rainy	41.388	0 - 50	Good	Green
2.	Cold	81.840	51 - 100	Moderate	Yellow
3.	Mean of Rainy and Cold	61.604	51 - 100	Moderate	Yellow

(Franics, 2016)

*all data are mg m⁻³

4. CONCLUSION:

From the study of particulate matter (PM-10) levels in ambient air of nine sampling sites in University of Yangon campus, the following inferences have been deduced. Particulate matter (PM-10) levels in all sampling sites (except UY-9 in cold season) are below the permissible limit. It was observed that concentrations of PM-10 were higher in cold season than rainy season. From the results of AAS study, heavy metals contents of PM-10 samples in cold season was found to be higher than those in rainy season. Concentrations of heavy metals (Cd, Cu, Pb and Mn) in PM-10 samples were found to be very small amount and within the permissible limit of OSHA (2017) and NIOSH (2017) standard. The smaller the concentration of heavy metals in PM-10, the better the air quality. According to the standard air quality index, the air quality conditions of PM-10 of University of Yangon is good air quality in rainy season and moderate air quality in cold season. Although University of Yangon campus is surrounded by the heavy traffic area, the air quality condition of   PM-10 in the campus is good till December, 2018.

REFERENCES:
1. Daly, A. and Z. Paolo. (2007). *An Introduction to Air Pollution.* California, The Enviro Comp Institute, Fremont, CA, USA, 1-8
2. Franics, O. A. (2016). Particulate Matter: An Approach To Air Pollution. *Research Gate,* 1 – 15
3. Uno, U. A., B. O. Ekpo, V. E. Etuk, and U. J. Ibok. (2013). "Comparative Study of Levels of Trace Metals in Airborne Particulates in Some Cities of the Niger Delta Region of Nigeria". *Environmental and Pollution., 2* (1), 110-121
4. WHO. (2000). *Air Quality Guidelines for Europe*. Copenhagen: 2nd Ed., WHO Regional Publications, European Series, No. 91
5. Wong, J. W. C, and N. K. Mak. (1997). "Heavy Metal Pollution in Children Play Grounds in Hong Kong and Its Health Implications*". Environ. Technol*, **12**, (18),109-115
6. Zixus, (2017). *Air Sampling Guide to HSE Methods*. UK:SCK Ltd., 144-211