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Comparison Of Ambient Air Aerosols Level In Abakaliki Urban, Ebonyi State Nigeria.

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Abstract
This study investigated the total suspended particulate (TSP) matter load and particulate matter with aerodynamic diameter 2.5 to 10 micrometers (PM_{10}) in ten areas in Abakaliki urban, Ebonyi State Nigeria, during dry and wet seasons from December, 2008 to September, 2009 using photometric laser-based particle counter instrument. The results showed that the seasonal mean varied in the range of 25.06 ± 5.42 to 89.06 ± 6.05µgm^{-3} for the TSP in the dry season and 5.94 ± 1.61 to 35.38 ± 5.43µgm^{-3} for the wet season. The seasonal mean of (PM_{10}) ranged from 8.56 ±2.56 to 73.06 ± 2.79 and 3.69 ± 1.14 to 16.50 ± 5.15 µgm^{-3} for the dry and wet seasons respectively. The annual mean of TSP in all the locations were within World Health Organization (WHO) annual guideline limit of 230-250µgm^{-3} whereas PM_{10} annual mean levels in three locations (Presco Junction, Spera Indeo Junction and Abakaliki Rice Mill) exceeded the US annual National Ambient Air Quality Standard (NAAQS) of 20 µgm^{-3} and this calls for concern in view of the human health risk associated with particulate matter pollution.

Keywords: *Aerosol, Ambient air, particulate matter and Abakaliki urban.*

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I. Introduction

Aerosols are extremely small solid particles or very small liquid droplets, suspended in the atmosphere. Ambient air is atmospheric air in its natural state. It is what we breathe when the atmosphere is not contaminated by airborne pollutants. Nigeria is described as one of the heavily aerosol-laden regions of West Africa, where aerosol studies are of great interest. Studies have however shown that the major pollutant in Nigeria is dust aerosol and the strength of dust transport towards the Atlantic Ocean increases annually worsening the visibility condition in Nigeria. Aerosol particles scatter and absorb solar and terrestrial radiation. The recent upsurge in the quantum of research in the air environment may stem from increased awareness on the negative consequences of air pollution on public health, biotic and material component of the environment. For instance, air pollution particularly particulate matter (PM) has been implicated in the aggravation of respiratory and cardiovascular diseases [12, 14, 15, 16, and 18], retardation in growth and yield of plants [17], reduction in visibility [3, 8] and deterioration of the physical environment [5]. Processes that emit particulate matter into the atmosphere include: volcanic eruptions, geochemical sources, windblown dust, soil re-suspension, and spray from marine sources, power plant emissions, agricultural and industrial emissions, vehicular emissions [4, 6, and 19]. In Nigeria, just like other developing countries, real time continuous monitoring network stations are not yet in place. Particulate matter (PM) monitoring is still rudimentary, discontinuous, limited in scope and duration. As such, data on ambient air concentration of particulate matter is lacking for many urban areas in Nigeria with Abakaliki in focus. Available data of random sampling by researchers and consultants in some urban centres in the country showed that while some cities such as Lagos, Kano, Port Harcourt, Calabar, etc., have PM load above the WHO recommended limit [1, 2, 7, 9, 13], other cities such as Abakaliki and Ogoja have PM levels within the limit [10, 11]. Hence, this work aims at ascertaining the aerosols level (TSP and PM_{10}) in Abakaliki and its health implications in the area.

II. Experimental Details

Study Area

This study covered ten major urban areas in Abakaliki namely; Presco junction, Spera Indeo junction, Union Bank Roundabout, CAS campus gate, Abakaliki Rice Mill, Ishieke junction, Ishieke campus gate, House of Assembly gate, Old kpirikpiri market and Federal Medical Centre (FMC) which is now Federal Teaching Hospital Abakaliki 1 (FETHA 1).

In each of the locations monitored, a site was chosen in the 'heart' of the town based on visible human activities, high population density and traffic volume.

Abakaliki is the capital and the first largest urban area in Ebonyi State, South East Nigeria. It is located within latitude (6º 19¹) N and longitude (8º 06¹) E and has an approximate population of 134,102 according to the 2006 census figure. The climatic condition of the area is tropical, characterized by wet and dry seasons. The wet season sets in between April and October while the dry season is usually between November and March [20].

Table 1: Sampling locations and GPS Coordinates for Abakaliki urban, Ebonyi State Nigeria.

Site S/N	Location Name	GPS Coordinates Lat. (ºN), long. (ºE)
1	Presco Junction (P.J)	N06º 19.470¹, E008º 05.115¹
2	Spera Indeo junction (S.I.J)	N06º 18.579¹, E008º 05.405¹
3	Union Bank Roundabout (U.B.R)	N06º 19.475¹, E008º 05.558¹
4	CAS Campus Gate Ebsu (C.C.G.E)	N06º 19.418¹, E008º 07.700¹
5	Abakaliki Rice Mill (A.R.M)	N06º 19.107¹, E008º 08.119¹
6	Ishieke Junction (I.J)	N06º 22.324¹, E008º 01.456¹
7	Ishieke Campus Gate Ebsu (I.C.G.E)	N06º 22.675¹, E008º 02.584¹
8	Ebonyi State House of Assembly gate (E.S.H.A.G)	N06º 17.971¹, E008º 05.405¹
9	Old kpirikpiri Market (O.K.M)	N06º 19.942¹, E008º 05.989¹
10	Federal Medical Center (F.M.C)	N06º 19.882¹, E008º 06.447¹

Sources of Data

The data used in this work include total suspended particulate (TSP) matter load and particulate matter with aerodynamic diameter 2.5 to 10 micrometers (PM_{10}) in ten areas in the Abakaliki urban, Ebonyi State Nigeria, during dry and wet seasons between December, 2008 to September, 2009.

Data Analysis

The data collected are all weekly data but were processed to monthly data with Microsoft Excel package. Further analysis of the data were done using Statistical Package for Social Sciences (SPSS) Software.

III. Results And Discussion

Results

The results of the TSP and PM_{10} concentrations and their computed seasonal means are presented in Tables 2 and 3 and their seasonal variations depicted in figures 1 and 4, while their trends across the locations monitored within the period of the study are shown in figures 2, 3; 5 and 6 respectively.

Table 2: Weekly levels and seasonal mean of TSP (µgm^{-3}) in dry and wet seasons in the locations monitored.

	P.J		S.I.J		U.B.R		C.C.G.E		A.R.M		I.J		I.C.G.E		E.S.H
WK No	D	W	D	W	D	W	D	W	D	W	D	W	D	W	D
1	93	31	101	24	42	16	4	17	95	20	56	37	25	14	28
2	96	28	99	26	45	14	44	16	94	21	52	41	20	18	32
3	94	29	102	25	41	17	46	19	95	22	48	44	30	20	34
4	97	32	98	27	44	19	44	20	93	23	55	38	27	12	26
5	91	41	96	20	50	22	40	15	91	12	44	35	30	12	30
6	87	39	93	22	49	18	42	17	90	14	40	29	28	15	38
7	85	37	94	23	50	19	39	16	92	15	48	40	35	17	40
8	93	43	97	21	51	17	43	17	91	13	47	36	33	9	32
9	91	29	63	20	47	11	29	6	81	20	48	35	33	12	31
10	90	28	65	23	49	12	30	8	79	19	50	40	40	16	35
11	94	31	64	22	50	10	32	7	81	20	52	43	38	15	28
12	93	33	65	23	47	15	30	9	80	21	45	28	26	13	28
13	81	21	90	14	46	11	32	10	85	23	45	30	23	10	37
14	79	23	88	13	44	8	34	8	83	25	40	33	28	8	35
15	80	20	91	16	47	9	3	9	81	24	50	28	21	12	40
16	81	25	92	14	49	7	6	10	86	25	47	29	26	11	38
X̄	89.06	30.63	87.38	20.81	46.94	14.06	31.13	12.75	87.31	19.81	47.94	35.38	28.94	13.38	33.25
Std	6.05	6.80	14.32	4.39	3.04	4.48	14.44	4.75	5.88	4.20	4.60	5.43	5.73	3.30	4.55
A.M± A.Sd	59.84±41.32		54.09±47.07		30.50±23.25		21.94±12.99		53.56±47.73		41.66±8.88		21.16±11.00		22.38±

Foot note: P.J = Presco Junction, S.I.J = Spera Indeo Junction, U.B.R = Union Bank Roundabout, C.C.G.E = CAS Campus Gate Ebsu, A.R.M = Abakaliki Rice Mill, I.J = Ishieke Junction, I.C.G.E = Ishieke Campus Gate Ebsu, E.S.H.A.G = Ebonyi State House of Assembly Gate, O.K.M = Old Kpirikpiri Market, F.M.C = Federal

Medical Centre, D = Dry, W = Wet, = Mean, Std = Standard Deviaton, A. and A.Std = Annual Standard Deviation.

Table 3: Weekly levels and seasonal mean of PM_{10} (μgm^{-3}) in dry and wet seasons in the locations monitored.

	P.J		S.I.J		U.B.R		C.C.G.E		A.R.M		I.J		I.C.G.E		E.S.H./	
WK No	D	W	D	W	D	W	D	W	D	W	D	W	D	W	D	
1	30	7	76	21	14	5	38	4	37	16	29	8	20	10	18	
2	29	5	74	22	16	7	40	6	39	18	31	11	18	9	19	
3	32	8	78	19	13	6	41	3	40	15	27	14	21	10	16	
4	35	9	77	20	17	9	39	7	39	19	30	9	23	7	15	
5	35	15	71	17	18	6	13	4	36	13	30	9	21	9	18	
6	37	13	74	19	19	8	12	7	38	15	28	10	23	8	21	
7	39	16	75	17	20	6	14	3	39	14	31	8	20	9	22	
8	36	14	73	20	21	9	13	6	35	15	34	11	23	12	16	
9	33	13	71	18	14	4	39	4	25	10	28	8	20	8	14	
10	37	17	70	20	16	6	41	6	27	13	30	10	23	7	17	
11	35	14	72	17	15	7	38	4	29	11	32	9	25	9	18	
12	31	16	68	21	17	5	42	7	26	14	30	8	22	11	14	
13	32	16	75	9	21	5	11	3	26	7	25	8	15	9	19	
14	33	17	70	7	23	7	13	4	24	5	28	7	17	7	21	
15	32	15	71	9	24	6	14	5	27	7	30	10	20	10	22	
16	31	16	74	8	20	7	12	6	23	6	23	8	16	13	18	
X̄	33.56	13.19	73.06	16.50	18.00	6.44	26.25	4.94	31.88	12.38	29.13	9.13	20.44	9.25	18.00	
Std	2.83	3.82	2.79	5.15	3.31	1.41	13.10	1.48	6.44	4.29	2.66	1.41	2.80	1.73	2.61	
A.X̄± A.Std	23.38±14.41		44.78±40.00		12.22±8.18		15.59±15.07		22.13±13.79		19.13±14.14		14.84±7.91		11.97±8	

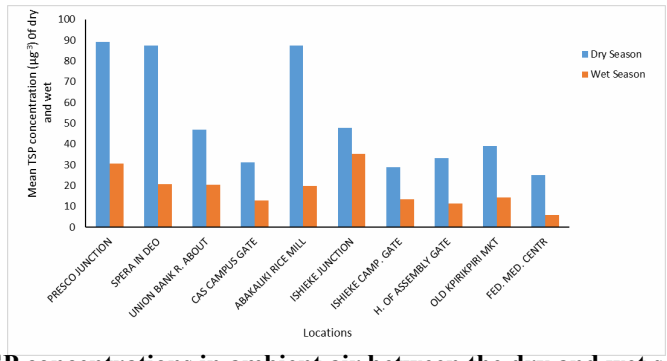

Fig. 1: Variations of TSP concentrations in ambient air between the dry and wet seasons across locations in Abakaliki, Ebonyi State Nigeria.

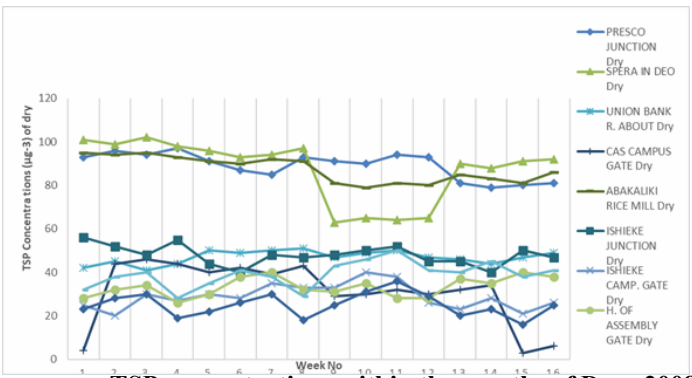

Fig. 2: Trend of dry season TSP concentrations within the months of Dec., 2008 to March, 2009.

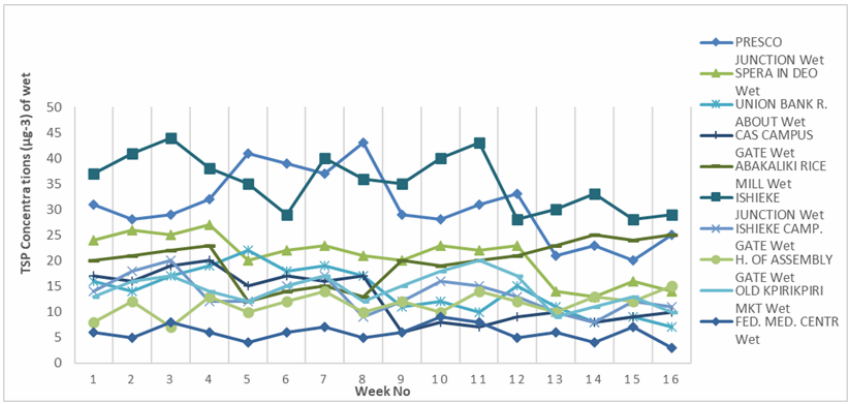

Fig. 3: Trend of wet season TSP concentrations within the months of June to September, 2009.

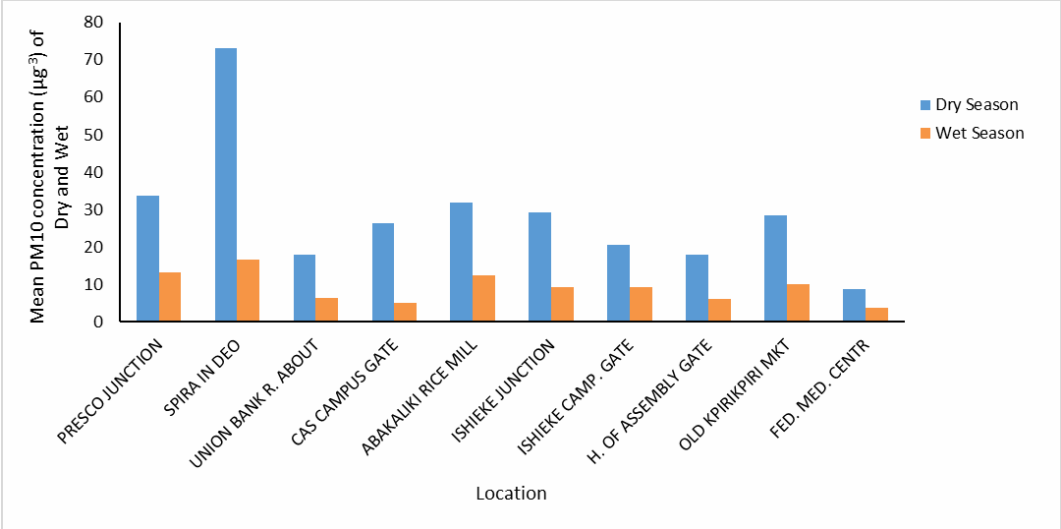

Fig. 4: Variations of PM_{10} concentrations in ambient air between the dry and wet seasons across locations in Abakaliki, Ebonyi State Nigeria.

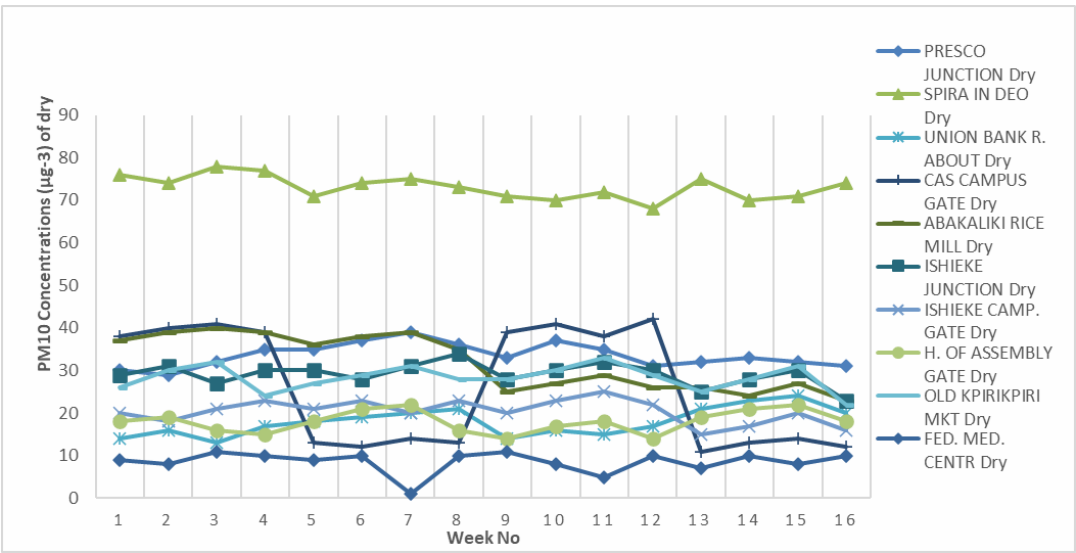

Fig. 5: Trend of dry season PM_{10} concentrations within the months of Dec., 2008 to March, 2009.

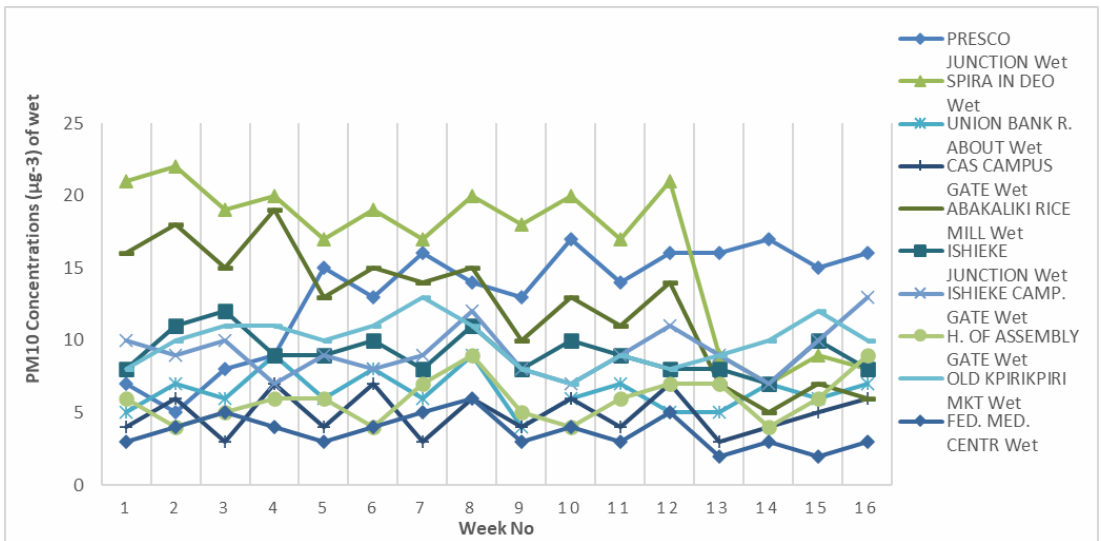

Fig. 6: Trend of wet season PM_{10} concentrations within the months of June to September, 2009.

Discussion

The highest dry seasonal mean TSP concentration of 89.06 ± 6.05μgm^{-3} was recorded in Presco Junction (P.J) while the least dry value of 25.06 ± 5.42 μgm^{-3} was recorded in Federal Teaching Hospital Abakaliki (FETHA 1). Similarly, in the wet season, Ishieke Junction (I.J) recorded the maximum level of 35.38 ± 5.43 μgm^{-3} while the minimum wet value of 5.94 ± 1.61μgm^{-3} was obtained in FETHA 1. The annual mean TSP levels ranged from 21.16 ± 11.00 – 59.84 ± 41.32μgm^{-3} (Table 2). In view of the above result, it suggests that the axis of Presco Junction and Ishieke Junction had higher particulate matter (PM) load in both dry and wet seasons whereas that of FETHA 1 had the least in both seasons as seen in Fig. 1 above. Also, the annual mean levels were below the 230 – 250 μgm^{-3} WHO annual guideline limit.

Spera Indeo Junction (S.I.J) recorded the highest PM_{10} level of 73.06 ± 2.79 μgm^{-3} in the dry season while the least level in the dry season of 8.56 ± 2.56μgm^{-3} in FETHA 1 as against the wet season maximum and minimum levels of 16.50 ± 5.15μgm^{-3} and 3.69 ± 1.14μgm^{-3} obtained in Spera Indeo Junction and FETHA 1 respectively. The annual mean PM_{10} levels ranged from 6.13 ± 3.45 – 44.78 ± 40.00μgm^{-3} (Table 3). This result suggests that the axis of Spera Indeo Junction had higher particulate matter (PM) load in both dry and wet seasons while that of FETHA 1 had the least in both seasons as seen in Fig. 4 above, and the annual mean levels of Presco Junction, Spera Indeo Junction and Abakaliki Rice Mill exceeded the annual US National Ambient Air Quality Standard (NAAQS) limit of 20μgm^{-3}.

Comparatively, the levels of suspended particulate matter (SPM) in the dry season were higher than those of the wet season across the locations monitored. Also, SPM levels (TSP and PM_{10}) in Presco Junction, Spera Indeo Junction, Abakaliki Rice Mill and Ishieke Junction were consistently higher than those of other locations (Figure; 1 and 4). The higher PM level of Presco Junction relative to more urbanized locations like Spera Indeo Junction, Abakaliki Rice Mill and Ishieke Junction may be due to the various road construction works going on in those locations during the monitoring period with its attendant dust suspension characteristics.

Generally, the trends of the Suspended Particulate Matter (SPM) within the dry season showed a slight elevation in the first four weeks of the period and a more or less dipping towards the end of the monitoring period in most of the locations monitored with the exception of Spera Indeo Junction in figure 5 that showed a separate marked elevation from the commencement of the period to the end of the period due to high and almost uniform concentrations throughout the monitoring period. The elevation in the first four weeks corresponds to the period of harmattan in the South-East when the ambient air PM load is usually elevated due to the North-East trade wind laden with dust that is prevalent within this period. In the wet season, the trend depicts higher levels at the beginning of the period and then gradual dipping due to wet precipitation (atmospheric clean-up by rain) as the rainy season heightens. In other words, the ambient air particulate matter (PM) level decreases with increase in rainy season due to wet precipitation.

The annual mean TSP in all the locations were below the 230-250 μgm^{-3} WHO annual guideline limit. In contrast, only the annual mean PM_{10} in Presco Junction, Spera Indeo Junction and Abakaliki Rice Mill exceeded the annual US National Ambient Air Quality Standard (NAAQS) limit of 20 μgm^{-3}.

IV. Conclusion

Comparatively, the suspended particulate matter (SPM) levels in Presco Junction, Spera Indeo Junction, Abakaliki Rice Mill and Ishieke Junction were relatively higher than those of the other six locations monitored while FETHA 1 had the least particulate matter (PM) load in both dry and wet seasons for TSP and PM_{10} respectively. The study concludes that within the period of the research, the TSP levels were within the World Health Organization (WHO) annual guideline limit while levels of PM_{10} either exceeded or were very close to the guideline limits in all the locations monitored and this calls for concern in view of the human health risk associated with particulate matter pollution.

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