Comparative Assessment of Seasonal Air Pollution in Rural and Urban Areas of Rivers State, Nigeria

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ABSTRACT

Ordinarily, the air quality in the rural areas were supposed to be cleaner than in the urban areas because of the natural sinks in the rural areas. However, owing to the recent practices in the rural areas, the air quality in the area is no longer different from what is experience in the urban areas. The study examined comparative assessment of seasonal air pollution in rural and urban areas in Rivers State, Nigeria. Longitudinal type of descriptive research design was adopted for the study. Samples were taken from 26 communities cutting across both the rural and urban areas of the state during the wet and dry seasons using Aeroqual 500 series gas monitor, Bosean multi gas detector, EG Air quality detector, Blatn air quality detector, met metre as well as a GPS device. The pollutants that were assessed are O_3, CO, PM, SO_2, NO_2, VOC, CH_4, H_2S, NH_3 and CO_2, Relative Humidity, Wind Speed, Temperature and Wind Direction. It was found that Some communities have higher concentrations in certain pollutants than other. The rural areas' air pollutant concentrations were on the increase amidst the presence of features which could naturally bring down the concentrations. Urban areas tend to exhibit more consistent air quality patterns, but with higher concentrations of pollutants such as CO, O_3, and $PM_{2.5}$ and PM_{10} while rural areas experience more significant differences in air quality, particularly for pollutants such as SO_2 and $PM_{1.0.}$ However, the air quality as measured for both the wet and dry seasons across the locations show remarkable differences as the concentrations for the dry season are higher than those of the wet season. It was recommended that the rural and urban areas in Rivers State be equipped with more comprehensive and widespread air quality monitoring stations to track changes in real time. This would help in understanding pollution hot-spots and provide valuable data for decision making.

Keywords: Air Pollution, Assessment, Rural Area, Urban Area, Seasons.

INTRODUCTION

Many of the contributors of air pollution are also sources of greenhouse emission (WHO, 2023). The chemical composition of surrounding air is very complex, mostly in the developing world, as a result of greater proportion of old, poorly maintained vehicles as well as poor fuel quality (Baumbach et al., 1995; Gwilliam, 2003). Furthermore, there is a growing concern in the aspect of illegal refining of petroleum products as one of the chief contributors of air pollution in the developing nation for instance, Nigeria. The government had and continuously fought to put an end to it but not for the interest of protecting the environment from being polluted. Here in Rivers State especially in the rural part, there is an increase in artisanal refining activities which could have great impact on the local air quality (Ebe et al., 2025). However, apart from the activities of artisanal refiners and vehicular emission in the rural and urban areas of Rivers State, deforestation and bush burning has also contributed greatly to the present challenges of air pollution in the area.

When the air is polluted, it generally reduces the quality of this air which could have a deleterious effect on lives upon inhalation. Air pollution can cause diseases, allergies, and even death to humans; it can also cause harm to other living organisms such as animals and food crops, and may damage the natural environment for

example, climate change, ozone layer depletion or environmental degradation or built environment for example, acid rain (Manisalidis et al., 2020).

Poor air quality emanating from the burning of fossil fuel as well as other sources of air pollution has undoubtedly led to increasing hospital record of cancer, especially lung cancer (WHO, 2014).

Niger-Delta region of Nigeria which Rivers State is part of, are greatly experiencing air pollution concern due to crude oil exploration as well as flaring of gas into the surrounding air (Obisesan & Weli, 2019).

"According to a report from a study, it was reported that the density of power generating plants in some part of the study area emit larger amount of CO to the ambient air and increases the concentrations above recommended limit. This was observed in some communities such as UniPort, University of Education, Elekahia and Rumuagholu with the concentrations at about 45.70ppm, 34.33ppm, 16.62ppm and 14.22ppm respectively. They affirmed that these concentrations when compared was above the epidemiological standard baseline of 10-20ppm" (Elenwo & Ebe, 2019).

Some of the air pollutants such as CO, O_3, NH_3, $PM_{2.5}$ and PM_{10} were above the permissible limit of WHO air quality guidelines and this could have a deleterious effect if the sources of these pollutants are not abated (Ebe et al., 2025). This air pollution that has resulted to poor air quality in the study area has far reaching consequences other than cancer. The local climate of these areas is also affected as this could be seen on the increase in temperature where one finds it difficult at times to sleep at night. Air pollution can be caused by both human and natural phenomena, but the human-induced air pollution is alarming as its impact is greatly observed around the world (Dimitriou & Christidou, 2011). Thus, air quality is closely related to the Earth's climate and ecosystems globally. The concentrations of these pollutants in the atmosphere vary with season. As such, they are generally higher during the dry season compared to the wet season (Ebe et al., 2025; Obisesan & Weli, 2019). It is against this backdrop, that the present study deemed it fit to carry out comparative assessment of seasonal air pollution in Rural and Urban Areas in Rivers State, Nigeria.

The study was therefore necessitated by the increasing air pollution to comparatively assess the seasonal air pollution in rural and urban areas of rivers state, Nigeria. This will be achieved by assessing the seasonal (wet and dry) air pollutant concentrations in rural and urban areas and comparing the air quality of the rural area to those of the urban area in Rivers State, Nigeria

MATERIALS AND METHOD

Study Area

The study area is Rivers State which has 23 local government areas (LGAs) as shown in Figure 1; it is one of the six states that make up the South-South geopolitical zone of Nigeria. It is bounded to the North by Imo, Abia, and Anambra States, to the East by Akwa Ibom State, to the South by the Atlantic Ocean, and to the West by Bayelsa and Delta States. The state capital is Port Harcourt. Rivers State lies at Latitude 4^{o}45' North and Longitude 6^{o}50' East. It covers an area of 11,077 square kilometres (Oyegun & Ademola, 1999).

Research Design

The design for the study was descriptive (Longitudinal) research design, which involves describing the characteristics or behaviours of a population or phenomenon without manipulating the variables. Here, field assessment and description of the air qualities and the meteorological variables of interest were carried out in the field during the wet and dry seasons. The instruments for this study were Aeroqual-500 series gas monitor, Bosean multi gas detector, EG Air quality detector, Blatn air quality detector, met metre as well as a GPS device.

Total of eight (8) local government areas in Rivers State cutting across all the senatorial zones were selected (6 rural and 2 urban). In the rural LGAs, three (3) communities in each were randomly selected and sampled for assessment, while in the urban LGAs, a total of eight communities were randomly selected based on

geographic spread. These summed up to a total of 26 communities for both the rural and urban LGAs for the assessment of air pollution. The justification for the selection of the communities was based on geographic spread as well as accessible terrain. The parameters that were assessed were O_3, CO, PM, SO_2, NO_2, VOC, CH_4, H_2S, NH_3 and CO_2, Relative Humidity, Wind Speed, Temperature and Wind Direction.

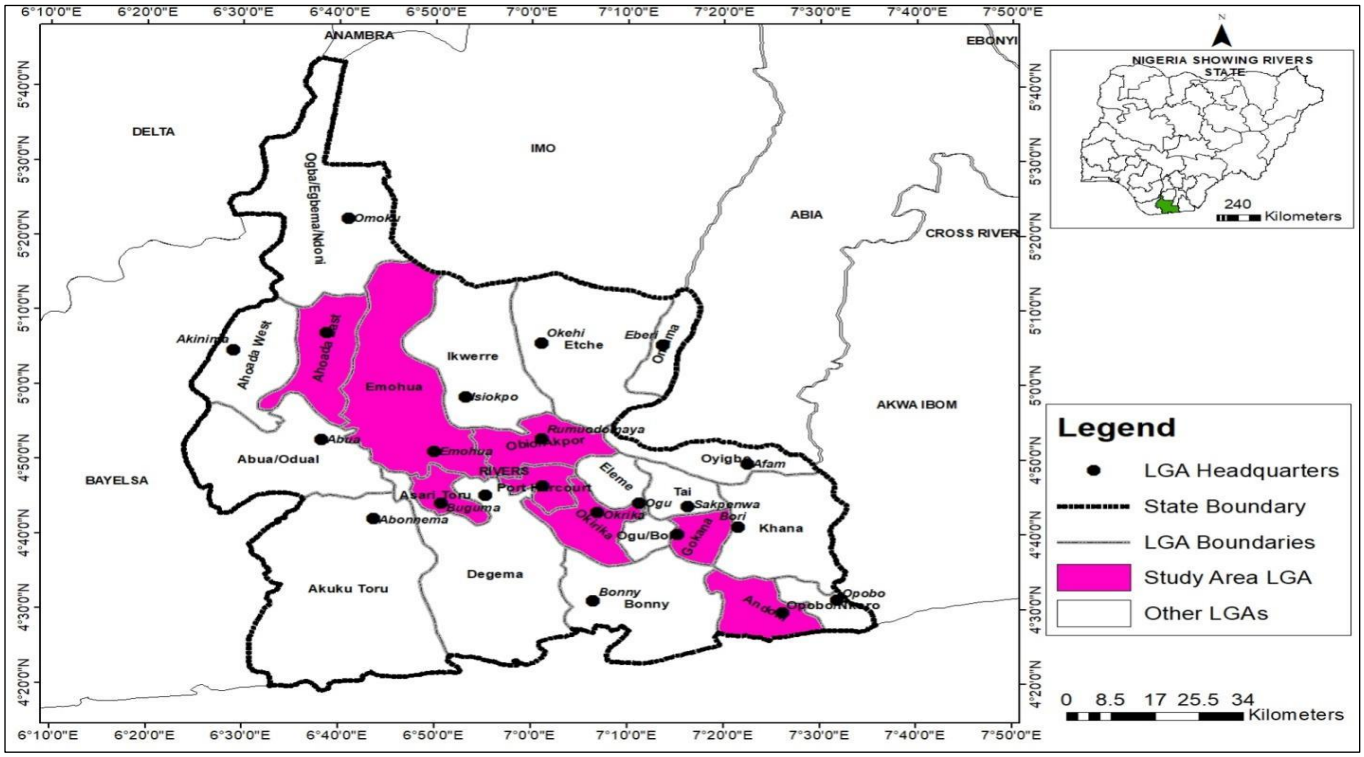

Figure 1: Rural and Urban Areas in Rivers State

RESULTS AND DISCUSSION

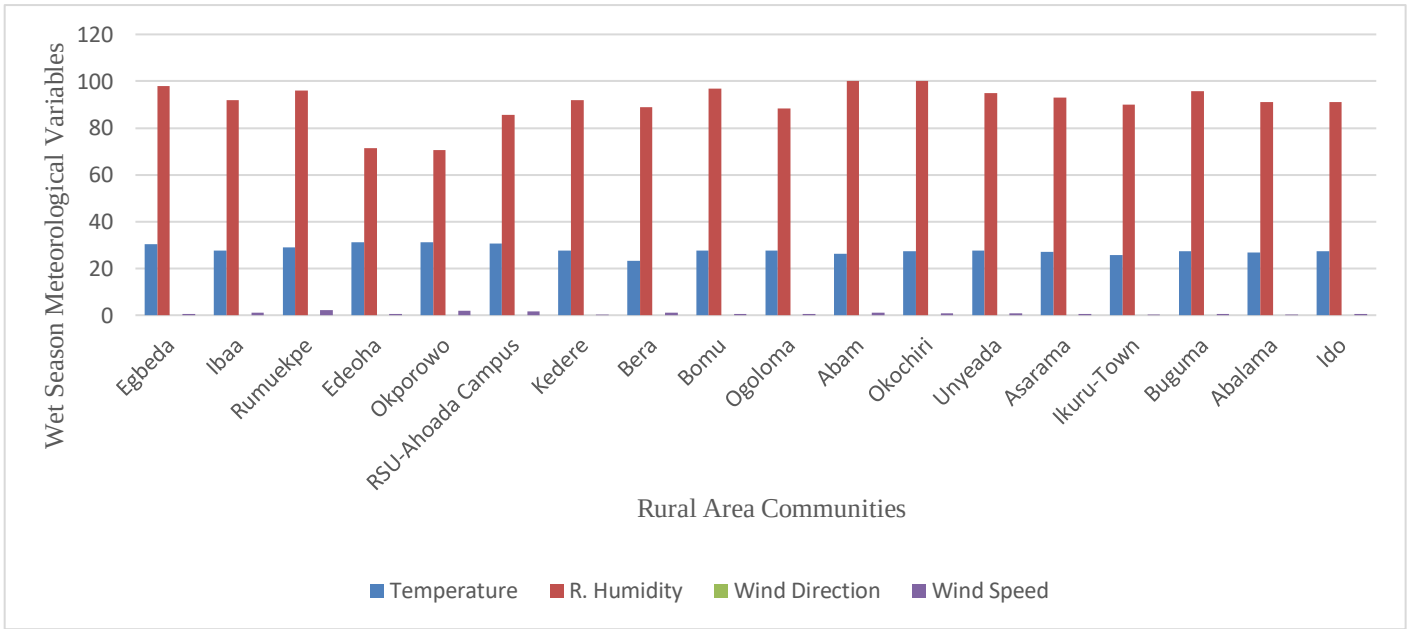

Figure 2: Mean Concentrations of Meteorological Variables During the Wet Season in the Rural Area

Figure 2 presents the mean meteorological variables during the wet season in the rural areas of the study area. The meteorological variables that were assessed were temperature, relative humidity, wind direction and wind speed. As seen on the figure during this season, relative humidity was observably high while the ambient temperature was low.

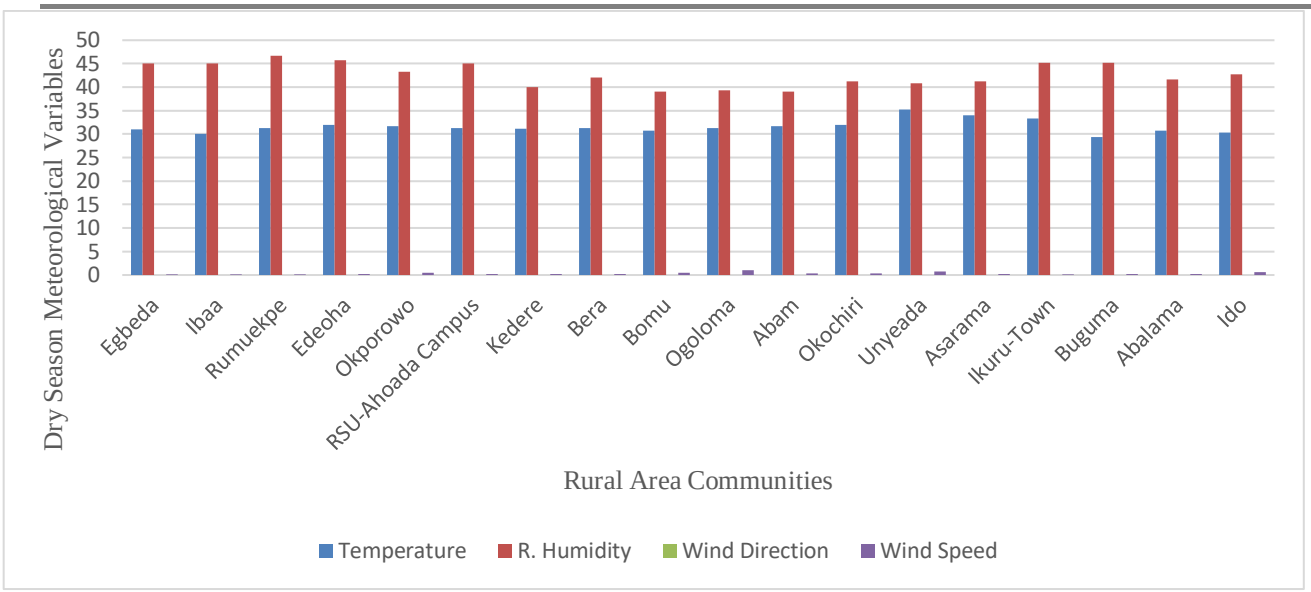

Figure 3: Mean Concentrations of Meteorological Variables during the Dry Season in the Rural Area

Figure 3 presents the mean meteorological variables during the dry season in the rural areas of rivers state. The meteorological variables of interest were temperature, relative humidity, wind direction and wind speed. These were assessed across selected communities in six (6) local government areas. As observed on the figure, the ambient temperature as recorded was high with low relative humidity than in the wet season.

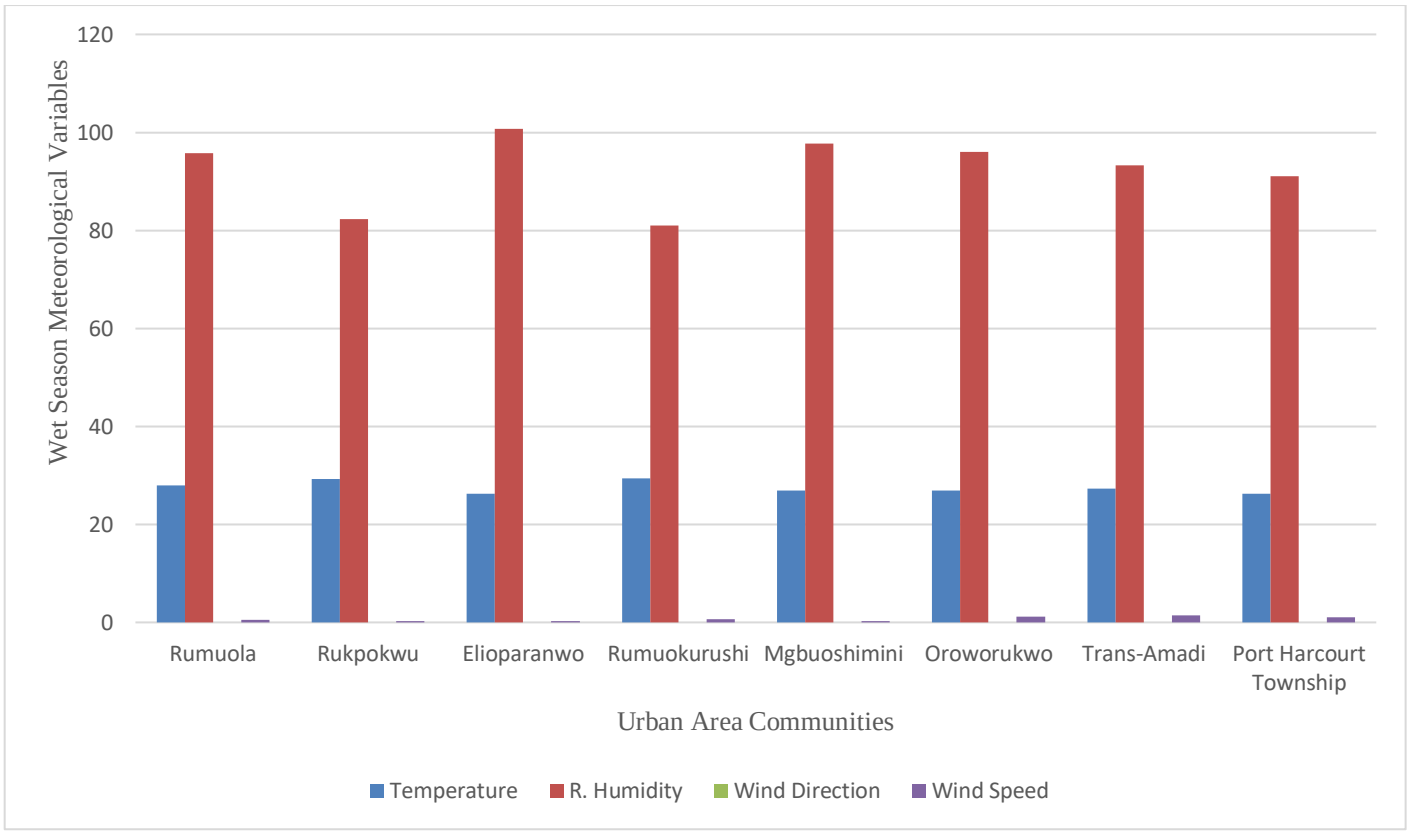

Figure 4: Mean Concentrations of Meteorological Variables during the Wet season in the Urban Area

Figure 4 shows the mean meteorological variables during the wet season in the urban areas of rivers state. The meteorological variables were temperature, relative humidity, wind direction and wind speed. These were carried out in selected communities making up the urban areas as seen on the figure. The table showed that the relative humidity was high while the ambient temperature was low during the season. The prevailing wind during this time was North-West.

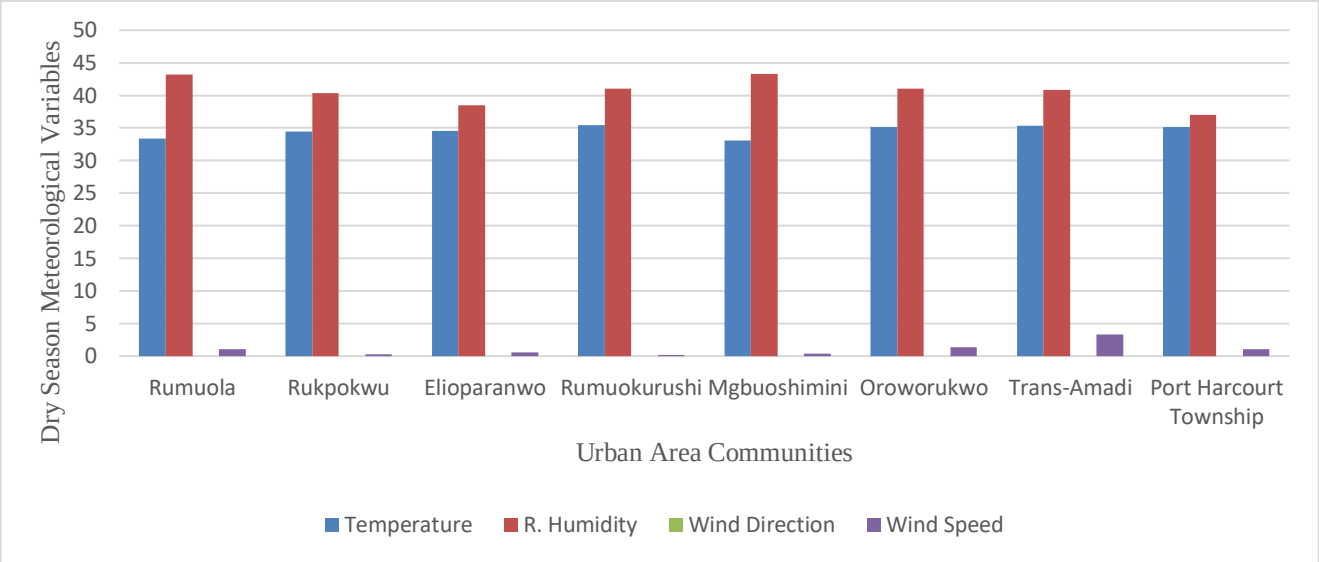

Figure 5: Mean Concentrations of Meteorological Variables during the Dry Season in the Urban Area

Figure 5 presents the mean meteorological variables during the dry season in the urban areas of rivers state. The meteorological variables of interest were temperature, relative humidity, wind direction and wind speed. The assessment was carried out in selected communities making up the urban areas as seen on the table. As shown, the relative humidity was low with increasing ambient temperature. The wind direction during this time of measurement were North-East with variable wind speed.

Table 1: Mean Concentrations of Air Pollutants during the Wet Season in the Rural Area

Parameters/Locations	SO_2	NO_2	CO	CH_4	VOC	H_2S	NH_3	CO_2	O_3	PM2.5	PM10	PM 1.0
Egbeda	0.16	0.05	0.57	0.018	0.27	0.005	0.27	628	0.02	20	21	17
Ibaa	0.3	0.06	1.4	0.017	0.332	0.005	0.23	624	0.02	22	27	19
Rumuekpe	0.2	0.03	1.5	0.03	0.094	0.003	0.4	632	0.03	32	36	31
Edeoha	0.03	0.02	4.7	0.018	0.165	0.004	0.23	638.3	0.027	36.7	39.3	26.7
Okporowo	0.047	0.055	4.7	0.028	0.056	0.005	0.37	583.3	0.037	16.3	21.3	13
RSU-Ahoada Campus	0.051	0.047	2.7	0.019	0.046	0.001	0.27	611.7	0.013	11.7	14	9.33
Kedere	0.04	0.053	5.3	0.023	0.207	0.002	0.2	636.3	0.02	31.7	27.7	21.7
Bera	0.04	0.007	4	0.026	0.093	0.0023	0.33	629	0.003	46.3	34.3	27.7
Bomu	0.03	0.04	4.7	0.0157	0.208	0.0023	0.33	636.3	0.027	26.3	24	18
Ogoloma	0.0013	0.027	1.6	0.0137	0.0137	0.0017	0.13	619	0.013	16.3	23.7	12
Abam	0.017	0.07	1.03	0.0157	0.0173	0.0013	0.27	646.3	0.02	15.7	17.3	12.3
Okochiri	0.027	0.05	7.3	0.0157	0.0177	0.0047	0.43	781.3	0.37	15.7	18.3	14.3
Unyead	0.013	0.047	1.1	0.019	0.221	0.0013	0.27	612.7	0.013	29	22	16.3

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AS Arama	0.04	0.053	1.6	0.017	0.461	0.0017	0.33	620.7	0.037	34	27.7	19.7
Ikuru-Town	0.023	0.02	1.1	0.017	0.181	0.0023	0.13	617.7	0.027	95.3	25.7	26.7
Buguma	0.037	0.047	6.5	0.0343	0.226	0.0017	0.27	621	0.063	58.7	62.3	47.7
Abalama	0.027	0.033	4.3	0.0363	0.22	0.0013	0.133	597.3	0.0363	53.7	61.7	45.7
Ido	0.027	0.033	3.2	0.024	0.1483	0.0017	0.3	615.7	0.067	61	52	42
STD	0.0719	0.0152	1.804	0.0063	0.1106	0.00139	0.0737	42.11	0.0749	22.2	12.59	11.22

Table 2: Mean Concentrations of Air Pollutants during the Dry Season in the Rural Area

Parameters/Locations	SO_2	NO_2	CO	CH_4	VOC	H_2S	NH_3	CO_2	O_3	$PM_{2.5}$	PM_{10}	$PM_{1.0}$
Egbeda	0.3	0.08	4.4	0.057	0.834	0.008	0.4	729	0.3	83	93	62
Ibaa	0.4	0.07	8	0.072	0.74	0.007	0.3	814	0.3	85	94	67
Rumuekpe	0.3	0.07	9.7	0.085	0.567	0.005	0.5	821.7	0.3	65	73	42.7
Edeoha	0.14	0.14	7.3	0.042	0.758	0.006	0.47	820.3	0.51	86.7	97.7	73
Okporowo	0.08	0.12	6.3	0.062	0.82	0.011	0.67	797.3	0.68	84.7	98.3	75.7
RSU-Ahoada Campus	0.06	0.1	6.3	0.086	0.65	0.025	0.77	650.7	0.03	63.7	77.7	55
Kedere	0.103	0.05	6.33	0.0573	0.878	0.004	0.53	993.3	0.037	66	70.3	53.3
Bera	0.07	0.073	6.3	0.0813	0.577	0.0027	0.43	949.7	0.047	60.7	69	52
Bomu	0.107	0.1	8.7	0.047	0.863	0.005	0.57	838	0.037	55.7	67.7	46
Ogoloma	0.067	0.057	5.5	0.0653	0.841	0.0063	0.43	723.3	0.27	67	79.7	61.7
Abam	0.047	0.067	7	0.0683	0.752	0.0043	0.43	680.7	0.047	61.3	73.3	58.3
Okochiri	0.073	0.13	9.7	0.0956	0.956	0.0067	0.77	838	0.27	90	98	75
Unyeada	0.05	0.063	8	0.145	0.331	0.0027	0.67	679	0.2	38	32	21.3
Asarama	0.05	0.057	9.7	0.158	0.354	0.0037	0.63	686	0.07	44.7	32.3	21
Ikuru-Town	0.047	0.047	6.83	0.077	0.194	0.0013	0.57	625.3	0.067	112.7	30.3	40.7
Buguma	0.053	0.063	8.3	0.054	0.647	0.032	0.37	694.3	0.06	91	93	67

Abalama	0.043	0.057	6.17	0.0636	0.429	0.0037	0.33	647.7	0.17	85	96	65
Ido	0.03	0.043	7.67	0.053	0.3497	0.003	0.3	676.7	0.08	83.3	95.7	64.7
STD	**0.0939**	**0.0269**	**1.337**	**0.0303**	**0.1812**	**0.00752**	**0.1385**	**99.71**	**0.1745**	**14.82**	**2.070**	**15.05**

Table 3: Mean Concentrations of Air Pollutants during the Wet Season in the Urban Area

Parameters/Locations	SO_2	NO_2	CO	CH_4	VOC	H_2S	NH_3	CO_2	O_3	$PM_{2.5}$	PM_{10}	$PM_{1.0}$
Rumuola	0.053	0.053	9	0.215	0.269	0.0017	0.1	697.7	0.133	27.7	39	21
Rukpokwu	0.113	0.057	8.03	0.1473	0.2183	0.0013	0.033	631.7	0.05	23.7	22.3	18.7
Elioparanwo	0.077	0.05	5.67	0.0307	0.0203	0.0017	0.033	683	0.0167	58.3	54.7	40.3
Rumuokurushi	0.1	0.047	9.87	0.137	0.341	0.0023	0	647	0.04	47	33	22.7
Mgbuoshimini	0.053	0.047	6.27	0.1483	0.0187	0.0013	0.1	680.7	0.013	25.7	18.3	14.7
Oroworukwo	0.17	0.05	10	0.2177	0.0303	0.0023	0.133	693	0.23	38.7	20.7	14.3
Trans-Amadi	0.063	0.083	11.27	0.0483	0.1967	0.00267	0.27	774	0.103	34.3	28.3	19.7
Port Harcourt Township	0.067	0.063	11.17	0.019	0.0617	0.0037	0.077	718	0.04	27	15.3	11
STD	**0.027**	**0.020**	**2.07**	**0.249**	**0.1112**	**0.0008**	**0.0835**	**47.53**	**0.0386**	**11.56**	**11.88**	**4.63**

Table 4: Mean Concentrations of Air Pollutants during the Dry Season in the Urban Area

Here's your data converted into a well-formatted table:

Parameter/Location	**SO_2**	**NO_2**	**CO**	**CH_4**	**VOC**	**H_2S**	**NH_3**	**CO_2**	**O_3**	**PM2.5**	**PM10**	**PM1.0**
Rumuola	0.133	0.283	8.93	0.0853	0.2617	0.003	0.0833	738.7	0.09	77.7	90	58
Rukpokwu	0.11	0.06	8.3	0.063	0.2427	0.001	0.367	714	0.093	82	93.7	60.7
Elioparanwo	0.113	0.057	7.33	0.061	0.229	0.001	0.47	596.7	0.097	59.7	67	47.3
Rumuokurushi	0.147	0.08	10.73	0.1543	0.338	0.0023	0.47	817.7	0.093	82.7	80.7	59.7
Mgbuoshimini	0.107	0.05	6.87	0.066	0.3247	0.0013	0.567	750.3	0.33	82.7	91.7	62
Oroworukwo	0.17	0.073	11.17	0.053	0.2343	0.003	0.467	793.3	0.1	69	73.3	53

Trans-Amadi	0.163	0.1167	14.07	0.0863	0.578	0.003	0.6	940	0.1	84	77.3	64.3
Port Harcourt Township	0.117	0.073	9.33	0.0597	0.3847	0.0023	0.43	813.7	0.17	82.3	74	66.3
STD (Standard Deviation)	0.02507	0.091	2.36	0.0354	0.1193	0.0009017	0.1577	98.48	0.08379	10.13	11.743	6.30

Air pollutant assessment in the rural and urban areas in rivers state has shown some locations to have high concentrations in certain pollutants and low in some. This changes in the pollutant concentrations were also affected by the season according to Balogun and Odjugo (2022), Onwuna et al. (2022) and Gobo et al. (2012) as affirmed in the report of the present study. In some locations, there are peculiar activities which have been a regular practice and has continuously led to the increase in air pollution in the area. Such activities as were revealed and observed in the field were artisanal refining of crude, indiscriminate dumping of waste, silting of aquatic ecosystem, deforestation and bush burning. Such locations where these practices are common will invariably experience the menace of air pollution which could be detected using air quality measuring devices. As would be expected in the rural area, the air around here was supposed to be clean due to the natural settings where there is abundant distribution of vegetation and in some parts, aquatic ecosystem. These features are natural sinks for these pollutants. However, as reported by Ebe et al. (2025), the responses of the respondents in their study affirmed that the presence of artisanal refining activities in the area could be tied to the increase in air pollution than the sink can absorbed.

The seasons could have a profound effect on air pollutant concentrations according to Ebe et al. (2025), Weli and Adekunle (2014) and Yorkor et al. (2017). As observed in this report, during the wet season, air pollutant concentrations especially the particulate matters are on the decrease compared to the dry season across the study locations. This is understandably so because, during the wet season, these pollutants are removed from the atmosphere by rainfall and other accompanying phenomena (Weli & Adekunle, 2014).

Furthermore, when examining the respective air quality in the both locations (rural and urban), rural areas generally show higher concentrations. Locations such as Emohua and Gokana have high average values but with large variations, indicating that while overall air quality may be relatively poor, there are significant changes in pollution levels throughout the year. In contrast, urban areas such as Obio/Akpor and Port Harcourt show lower levels of air pollutant concentrations in certain pollutants but with less variation, indicating a more consistent lower level of pollution, despite being affected by urban emissions. However, particulate matter, carbon monoxide and ozone in Port Harcourt are higher than the WHO permissible limit which was also supported by the reports of Ede and Edokpa (2015); and Ebe et al. (2025).

Given the seasonal variations in air pollution concentrations, rural areas tend to experience a decline in air pollutants during the wet season, with a marked increase in variability. This is particularly evident in Emohua, Andoni and Ahoada-East, where the air pollutant concentrations drop significantly in the wet season compared to the dry season. This report was in line with the submissions of Ebe et al. (2025) and Akinfolarin et al. (2018). Urban areas, such as Port Harcourt and Obio/Akpor, show less seasonal variation in air pollution concentrations, although they still experience relatively poor air quality when it comes to “air quality index” rating which may be due to persistent emissions from vehicular traffic, industrial activities as well as other urban air pollution sources (Weli & Adekunle, 2014).

CONCLUSION

This study provided an in-depth analysis of the concentrations of seasonal air pollutants of concern in the area of study and meteorological variables in rural and urban areas of Rivers State. Some locations have higher concentrations in certain pollutants than the other. The rural area’s air pollutants concentrations were on the increase amidst the presence of features which could naturally bring down the concentrations. These futures such as the vegetation and the presence of water bodies (Rivers, Streams etc). The air quality as measured for both the wet and dry seasons across the locations shows remarkable differences as the concentrations for the dry season are higher than those of the wet season which is expected because of reduction in rainfall and

atmospheric movement during this period. Thus, the research provides valuable insights into the complexities of air pollution across different geographical locations and seasons, highlighting the challenges and opportunities for environmental management in Rivers State.

Rural and Urban areas in Rivers State should be equipped with more comprehensive and widespread air quality monitoring stations to track changes in real time. This would help in understanding pollution hot-spots and provide valuable data for decision making.

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