Seasonal Variation Analysis of Air Pollutants in Accra-Ghana

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Abstract

Meteorology is a major driving force to poor urban air quality. This is due to its ability to influence the emissions, transport, formation, and deposition of air pollutants. In this study, the relationship between meteorological parameters including temperature, relative humidity, wind speed and direction and ambient air pollutants concentrations such as PM2.5 in the capital city of Ghana was carried out for a continuous period of 12 months from March 2020 to February 2021. Clear seasonality was observed for PM2.5, meteorological parameters and the air quality index. Maximum concentrations of PM2.5 were recorded in winter leading to poor air quality. Wind speed and relative humidity reversely correlated with the air pollutant while temperature showed a positive correlation with PM2.5. north-easterly winds led to highest concentrations during the winter season while south-westerly winds prevail over Accra in summer. The results from air quality index (AQI) indicated that severely poor air prevails during the winter period. These results justify the crucial role of meteorological parameters in air pollution formation with large variations in different seasons. These findings can be employed to enhance the understanding of processes that lead to air pollution and improve the accuracy of air quality forecast under different meteorological conditions.

SEASONAL VARIATION ANALYSIS OF AIR POLLUTANTS OVER ACCRA

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Abstract

This study focused on the relationship between meteorological and particulate matter ($PM_{2.5}$) concentrations with seasonal variation. The findings suggested that the prevailing hamattan weather associated with calm, warm and dry dust laden winds caused severely poor air quality during winter. These results justify the crucial role of meteorological parameters in air pollution formation with seasonality.

Background and Objective

- Air pollution is an environmental health risk responsible for millions of deaths globally (WHO, 2016).
- Pollutant concentrations are driven by land-atmosphere interactions.
- The mean concentration of PM2.5 over Ghana (31.1 $\mu g/m3$) exceeded the recommended standards (10 $\mu g/m3$) by WHO (2016).
- About 28,000 premature deaths have been atrributed to exposure to air pollution in Ghana.
- There is the need to monitor the seasonal variation of air pollutants from meteorological dynamics.

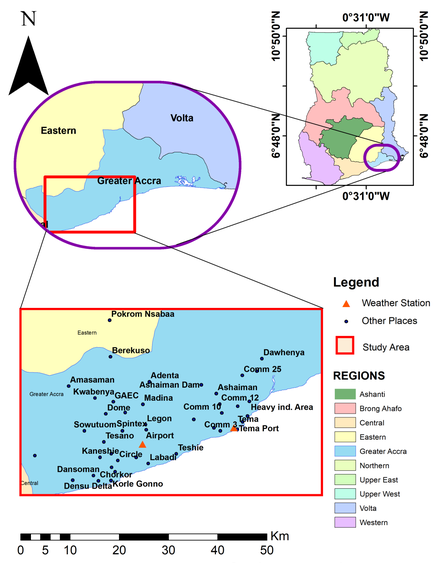

Figure 1: Map of the stduy area

The objectives of this research is to:

1. assess seasonal variation in meteorological parameters.
2. obtain air quality index (AQI) from PM2.5 concentration and assess seasonal variations in the pollutant and AQI.
3. determine the relationship between meteorological parameters and PM2.5.

Analysis

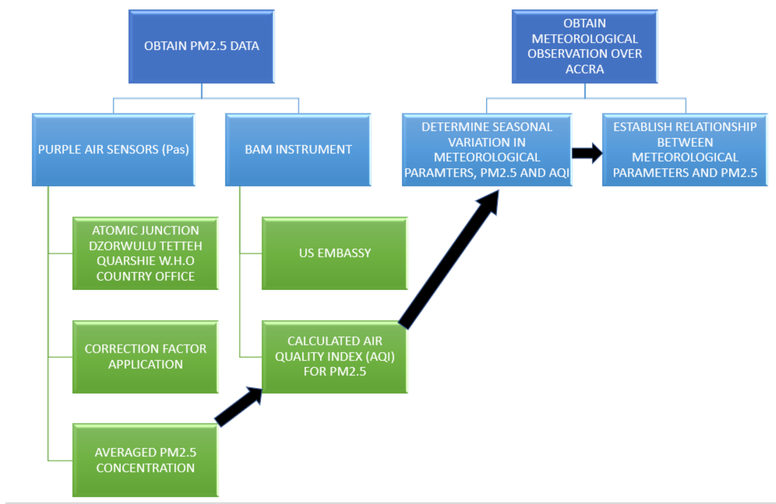

Figure 2: Flow chart of the analysis

Results 1

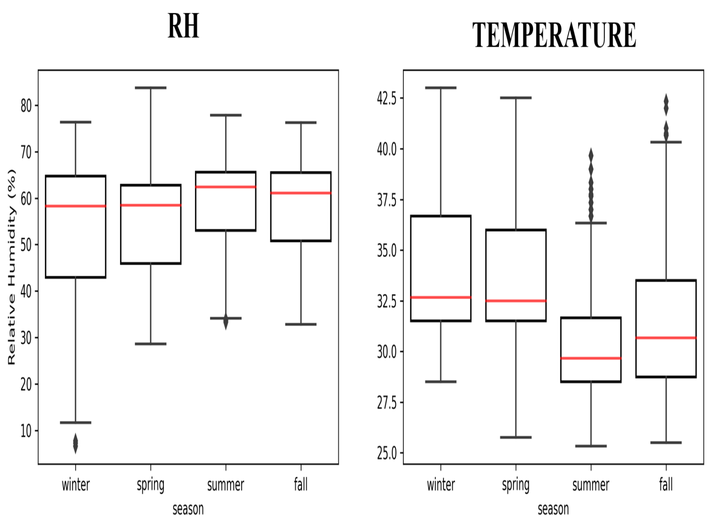

Figure 3: Seasonal variation in Temperature(a) and Relative humidity(b)

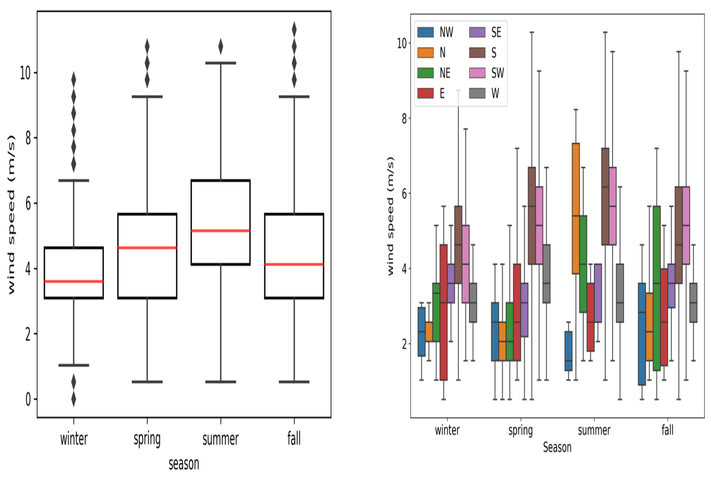

Figure 4: Seasonal variation in wind speed(a) and direction(b)

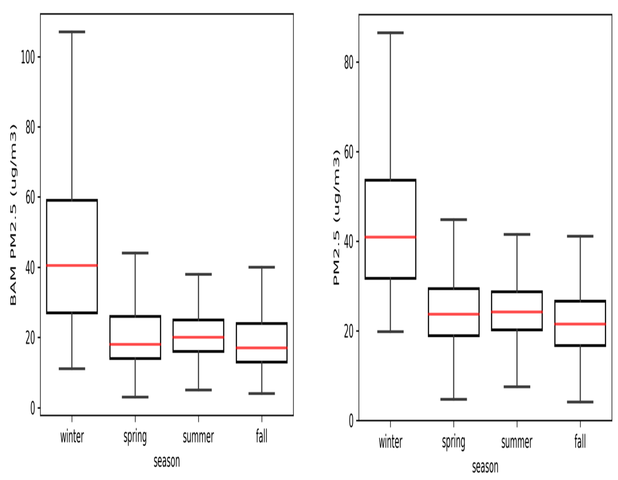

Figure 5: Seasonal variation in PM2.5 for Purple air(a) and BAM(b)

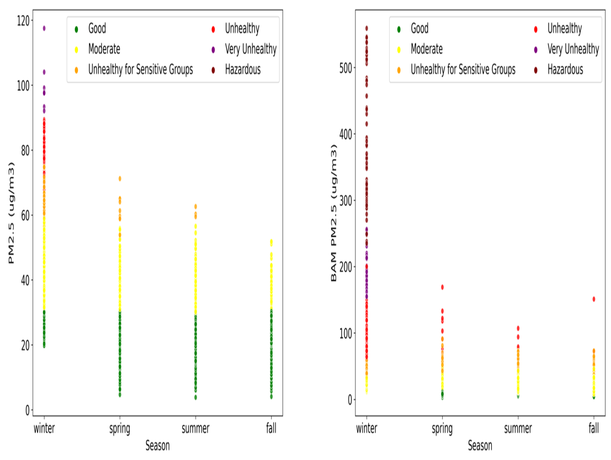

Figure 6: Seasonal variation in AQI for Purple air(a) and BAM(b)

Results 2

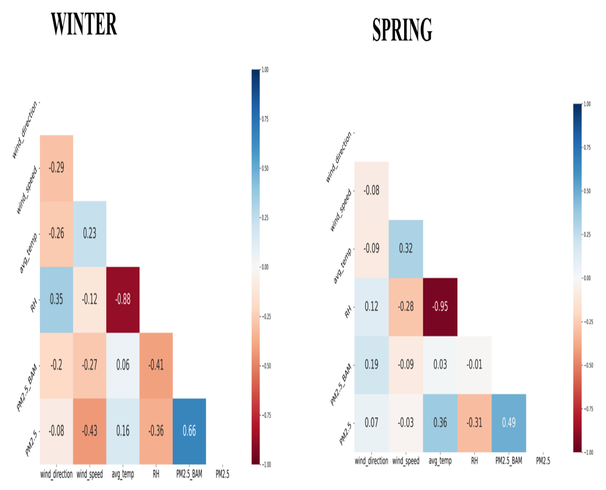

Figure 7: Correlation between meteorological parameters and PM2.5 in winter(a) and spring(b)

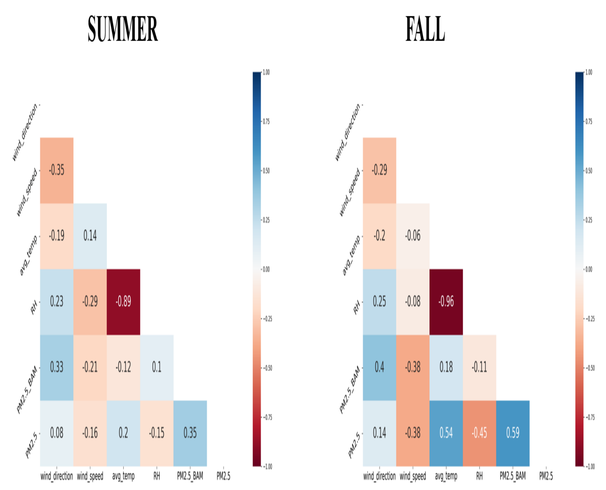

Figure 8: Correlation between meteorological parameters and PM2.5 in summer(a) and fall(b)

Discussion

- Seasonality was observed in meteorological parameters, $PM_{2.5}$ and AQI. $PM_{2.5}$ concentrations were higher in winter with severely poor air quality. This corresponds with relatively higher temperatures and lower relative humidity and calm winds.
- Generally $PM_{2.5}$ correlated positively with temperature and negatively with wind speed and relative humidity with weak and seasonal correlation variations.
- Poor air quality dominates during the winter period due to harmattan mostly associated with dusty calm and warm North-easterly winds with dry conditions.
- The findings suggests prevailing weather conditions greatly modulates air quality in Accra aside the anthropogenic activities and emissions.

Acknowledgement

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References

WHO (2016). Ambient air pollution: A global assessment of exposure and burden of disease.