



Article

Spatio-Temporal Variation in the Concentration of Inhalable Particulate Matter (PM₁₀) in Uganda

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Abstract: Long-term particulate matter (PM₁₀) measurements were conducted during the period January 2016 to September 2017 at three sites in Uganda (Mbarara, Kyebando, and Rubindi) representing a wide range of urbanization. Spatial, temporal and diurnal variations are assessed in this paper. Particulate matter (PM₁₀) samples were collected for 24-h periods on PTFE filters using a calibrated pump and analyzed gravimetrically to determine the average density. Particulate levels were monitored simultaneously using a light scattering instrument to acquire real time data from which diurnal variations were assessed. The PM₁₀ levels averaged over the sampling period at Mbarara, Kyebando, and Rubindi were 5.8, 8.4, and 6.5 times higher than the WHO annual air quality guideline of 20 $\mu\text{g}\cdot\text{m}^{-3}$, and values exceeded the 24-h mean PM₁₀ guideline of 50 $\mu\text{g}\cdot\text{m}^{-3}$ on 83, 100, and 86% of the sampling days. Higher concentrations were observed during dry seasons at all sites. Seasonal differences were statistically significant at Rubindi and Kyebando. Bimodal peaks were observed in the diurnal analysis with higher morning peaks at Mbarara and Kyebando, which points to the impact of traffic sources, while the higher evening peak at Rubindi points to the influence of dust suspension, roadside cooking and open-air waste burning. Long-term measurement showed unhealthy ambient air in all three locations tested in Uganda, with significant spatial and seasonal differences.

Keywords: particulate pollution; PM₁₀; ambient air; Uganda; urbanization

1. Introduction

Numerous human and environmental health concerns are concomitant to poor air quality. Approximately 4.2 million deaths worldwide in 2016 occurred due to ambient air pollution [1]. Numerous health problems are associated with exposure to inhalable particulate matter (PM₁₀, with aerodynamic diameter less than 10 micrometers) [2–7]. Although the consequences of poor air quality can be dire and deterioration is evident, no long-term air quality measurement has been reported in Uganda. However, a few short-term studies have reported polluted ambient air and recommended long-term measurements [8–11].

Uganda is a developing country in East Africa with a population of approximately 38 million people [12]. Its capital, Kampala, is highly urbanized, and numerous additional urban and sub-urban centers are emerging throughout the country. Most arise by the agglomeration of people due to necessity rather than planning, resulting in uncoordinated settlement and development [13]. For instance, in many of these urban and sub-urban centers, small- and large-scale factories are constructed side by side with residential housing. Also, these urban centers have many characteristics that have