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AERMOD EVALUATION FOR MODELLING THE DISPERSION OF PARTICULATE MATTER (PM_{10}) IN COMPLEX TOPOGRAPHY OF KIGALI, RWANDA

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Abstract

The dispersion of particulate matter (PM_{10}) in complex topographic areas is a scientific problem that poses significant challenges to human health, environmental scientists, and policymakers. To date, misused terrain elevation data in air quality modelling studies influence the over/under predictions results. The study evaluates the AERMOD model for modelling the dispersion of particulate matter (PM_{10}) in the complex topography of Kigali, Rwanda. It compares model outputs for four digital elevation models (DEMs), namely SRTM1 (30 m), SRTM3 (90 m), SRTM30 (900 m), and GTOPO30 (900 m). It evaluates the model performance using in-situ monitoring data and statistical metrics counting the fraction of predictions within a factor of two (FAC2), fractional bias (FB), mean bias (MB), geometric mean bias (MG), geometric variance (GV), normalized mean bias (NMB), and normalized mean squared error (NMSE). The annual averages of in-situ monitoring covering 12 months of 2021 at stations A, B, C, D, E, and F were 43.73 $\mu g\ m^{-3}$, 53.64 $\mu g\ m^{-3}$, 53.25 $\mu g\ m^{-3}$, 42.02 $\mu g\ m^{-3}$, 44.04 $\mu g\ m^{-3}$, and 56.01 $\mu g\ m^{-3}$, respectively. The 24-hour average for modelling results was 22 $\mu g\ m^{-3}$ for SRTM1 and 23 $\mu g\ m^{-3}$ for other DEMs, while the annual average was 10 $\mu g\ m^{-3}$ for all DEMs. The FB metric suggests that the choice of DEM significantly impacts the accuracy of the model predictions, with SRTM3 and GTOPO30 providing the best performance at stations A and F, whereas FAC2, MB, MG, GV, NMB, and NMSE provided a meaningful model performance at stations B, C, D, and E. The study provides valuable insights into the dispersion of PM_{10} in complex topographic areas and can help inform air quality models and policymaking in similar regions.

Key words: AERMOD, complex topography, in-situ monitoring, PM_{10}, statistical metrics, terrain elevation

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