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Vertical Distribution of CO₂ in Village, Urban, and Forest Environment: A Case Study from Gampaha, Sri Lanka**Jayathilaka, B.D.^{1*}, Halwatura, R.U.²**¹*Environment Management and Geo Resources Division, Department of Forest conservation, Battaramulla, Sri Lanka*²*Department of Civil Engineering, University of Moratuwa, Katubedda, Sri Lanka***devaneejayathilka@gmail.com***Abstract**

Understanding local variations in atmospheric Carbon Dioxide (CO₂) concentrations is essential for climate research, urban planning, and ecological studies. This study investigates the vertical distribution of CO₂ across three contrasting land-use types in Gampaha, Sri Lanka: village, urban, and forest environments. Measurements were conducted using CO₂ concentrations were measured at six vertical heights: 0 m (ground), 1,2,3,4 and, 5 m. A portable HT2000 CO₂ data logger (CO₂ Accuracy +70 ppm or +3% of reading in 400 ppm-2000 ppm) was used for consistency across all sites within each land-use type. Results indicate clear land-use dependency, with the highest CO₂ concentrations observed in traffic-heavy urban areas (up to ~606 ppm at ground level), intermediate levels in villages, and the lowest, more stable profiles in forested environments. The findings highlight the role of vegetation in buffering CO₂ levels and the contribution of anthropogenic activities to near-ground accumulation. These results provide insights for urban design, microclimate management, and climate adaptation strategies in tropical regions. Results revealed that urban traffic areas exhibited the highest CO₂ concentrations near the ground (up to 606 ppm), with a marked decline in concentration with increasing height, indicating localized emission hotspots and limited vertical dispersion. In contrast, forested environments demonstrated stable and lower CO₂ levels across all heights, reflecting their role as carbon sinks. Village environments showed mixed trends, with residential areas displaying decreasing CO₂ with height and paddy fields showing slight increases with the height, microbial activities in the muddy areas and the wind. The findings underscore the critical role of green infrastructure in moderating near-surface CO₂ concentrations and improving air quality in tropical urban environments. This study contributes new empirical data to the under-researched area of vertical CO₂ dynamics in South Asia and highlights the importance of integrating vegetation into urban planning to support climate adaptation and public health.

Keywords: *Carbon dioxide gradients, Vertical distribution, Land-use impacts, Urban-rural-forest comparison, Gampaha*