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Examining Urban Green and Brown Infrastructure's Impact on Air Pollution: A Spatial Analysis of School Environments in the Brussels Capital Region

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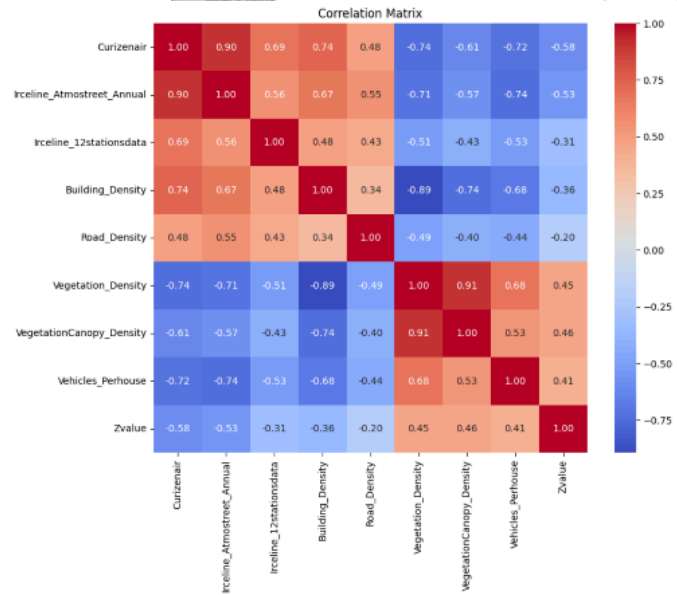
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Children spend approximately 1,300 hours annually in schools, making air quality in these environments crucial for their health and development. This study analyzes outdoor air pollution exposure around 844 schools in the Brussels Capital Region (BCR) using high-spatial-resolution NO₂ data from the Curieuzenair citizen science project (September–October 2021). The project collected measurements at 2,483 locations across BCR, with dataset validation against IRCELINE governmental data.

The research analyzed three categories of indicators within multiple buffer zones (150, 300, 600, and 800 meters) around schools: green infrastructure (vegetation and tree canopy density), brown infrastructure (building and street surface density), and contextual factors (vehicles per household and altitude). Analysis of 150-meter buffer zones revealed that 390 of 844 schools exceed the WHO NO₂ daily limit (25 µg/m³) based on Curieuzenair data, while 841 schools exceed the WHO annual limit (10 µg/m³) according to IRCELINE data. Results demonstrate that building density significantly correlates positively with NO₂ concentrations, while both vegetation density and vehicles per household show significant negative correlations. A key finding reveals that tree canopy, while beneficial, has less effect on NO₂ concentrations than overall vegetation. Clustering analysis reveals distinct spatial patterns, with central districts showing highest NO₂ levels due to dense brown infrastructure and limited green spaces.

To the authors' knowledge, this is the first study in BCR to comprehensively analyze the relationship between urban green-brown infrastructure and air quality across all school environments. The findings underscore the potential of integrating regulatory data with citizen science to inform urban planning strategies, specifically helping identify school environments where increasing ventilation and vegetation density would most effectively reduce air pollution exposure and promote healthier learning spaces.



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