Consequences of climate change on indoor air quality at primary schools in Madrid

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ABSTRACT

Indoor air quality (IAQ) in educational buildings is a critical public health issue, particularly for children, who are more vulnerable to pollutant exposure and spend prolonged periods indoors. While ventilation is widely promoted as a key mitigation strategy, its effectiveness for controlling volatile organic compounds (VOCs) remains insufficiently explored, especially in the context of climate change and evolving ventilation practices. This challenge is further amplified by current energy efficiency policies, which promote increased thermal insulation and more airtight building envelopes, often resulting in significantly reduced levels of uncontrolled ventilation.

This study focuses on VOC concentrations in primary school classrooms in the Madrid region, with particular attention to emissions associated with common educational materials and classroom activities. Two representative schools are analysed: one equipped with mechanical ventilation and one relying exclusively on natural ventilation. The analysis is based on in situ monitoring campaigns conducted across multiple periods, combining spatially distributed measurements of indoor air quality with detailed records of classroom activities, ventilation practices, and occupancy patterns.

Results indicate that VOC levels are primarily influenced by material-related emissions and usage patterns. Differences observed between the two schools suggest that ventilation performance for VOC removal depends not only on the type of system implemented, but also on operational conditions, maintenance practices, and user interaction. These findings highlight the need to assess ventilation strategies beyond nominal air change rates, incorporating source control and real operating conditions, particularly under climate-driven constraints affecting window opening.

This work contributes to the broader framework of the doctoral research “Energy efficiency and indoor air quality in schools in the city of Madrid and its periphery”, providing evidence-based insights to support the development of robust and resilient ventilation strategies for healthy school environments.

KEYWORDS

Indoor air quality, Volatile organic compounds, School buildings, Ventilation strategies, Energy efficiency and airtightness