

Dust Storms in Tehran: An Environmental and Health Challenge

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Letter to the Editor

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Dear Editor,

This letter discusses the growing environmental and public health significance of dust storms in Tehran, highlighting their underlying drivers, health consequences, monitoring approaches, and management implications. The aim of this letter is to emphasize the necessity of integrated dust storm management in Tehran. Over recent decades, the increasing frequency and intensity of dust storms worldwide, particularly across the Middle East, have emerged as a major challenge for public health, urban sustainability, and environmental management. As an important source of air pollution, dust storms impose substantial health, social, economic, and environmental burdens (1). The World Health Organization has identified particulate matter as one of the leading environmental risk factors and has emphasized its contribution to the global burden of non-communicable diseases (2).

Tehran, the capital of Iran and one of the most densely populated metropolitan areas in the Middle East, is particularly vulnerable to dust pollution due to its distinctive geographical and climatic conditions. Tehran's location at the foothills of the Alborz Mountains, combined with its proximity to arid and semi-arid landscapes, declining precipitation, climate variability, and rapid urban expansion, creates favorable conditions for the accumulation and persistence of airborne dust.

Furthermore, evidence suggests that dust pollution in Tehran is not solely driven by local factors such as soil erosion, vegetation degradation, and desertification, but is also significantly influenced by regional and transboundary dust sources that contribute to elevated concentrations of atmospheric particulate matter (3,4).

In this context, the role of Tehran Municipality is crucial in coordinating urban environmental management and implementing localized mitigation policies.

Recent advances in environmental monitoring technologies, particularly satellite-based remote sensing, have substantially improved the assessment and characterization of dust events. Indicators such as Aerosol Optical Depth (AOD) derived from MODIS products are widely used to evaluate the spatiotemporal dynamics, intensity, and spatial extent of dust storms (5,6). In addition, atmospheric trajectory models, including the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model, have become essential tools for tracing dust transport pathways and identifying regional and transboundary source areas affecting urban environments such as Tehran (7,8).

Numerous studies have demonstrated that elevated concentrations of particulate matter, particularly PM₁₀ and PM_{2.5}, are associated with increased risks of cardiovascular and respiratory diseases, emergency department visits, hospital

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admissions, and premature mortality (9,10). These adverse effects disproportionately affect vulnerable groups, including children, older adults, and individuals with pre-existing chronic conditions. Beyond their direct health impacts, dust storms also reduce visibility, disrupt urban and intercity transportation systems, increase the risk of traffic accidents, and diminish overall urban quality of life (11).

Given the multifactorial and transboundary nature of dust storms, effective mitigation and management require a comprehensive, integrated, and evidence-based approach. Key strategies include reducing dust generation through soil stabilization and vegetation restoration, promoting sustainable land and water resource management, expanding the application of advanced monitoring and forecasting technologies, developing early warning systems, and enhancing public awareness. Together, these measures represent essential components of a long-term strategy to mitigate the adverse impacts of dust storms in large urban centers (12,13).

It is hoped that the issues highlighted in this letter will encourage greater attention from researchers, policymakers, and urban managers toward the need for continuous monitoring and scientifically informed management of dust storms in Tehran. More broadly, the Tehran experience offers valuable insights for other dust-affected cities located in arid and semi-arid regions. Given the increasing frequency of dust events under changing climatic and land-use conditions, regional cooperation, continuous environmental monitoring, and evidence-based management strategies are essential for protecting public health and enhancing urban environmental resilience.

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