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Following the trails of Indian Atmospheric Lead (Pb)

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Atmospheric lead (Pb) pollution remains a persistent environmental and public health concern, particularly in developing nations like India. This study provides a comprehensive analysis of Pb sources, apportionment, and potential remediation strategies in India's atmospheric environment. Utilizing isotopic and elemental concentration analyses, the study traces Pb origins across urban, industrial, and pristine regions, identifying key anthropogenic and natural contributors. The study integrates statistical modeling, including Bayesian mixing models and air mass back trajectory analyses, to establish the significance of various Pb sources.

Andaman and Nicobar Islands in the Bay of Bengal was chosen as a control site, as the archipelago has minimal industrial activity. Lead sources exhibit distinct seasonal variations. Transboundary transport of aerosols from Southeast Asia dominates during winter, whereas local emissions, including vehicular and ship emissions, and military activities, play a more significant role during the monsoon season. Pb isotopic analyses indicate that bullet emissions are substantial Pb sources in the island, a previously unrecognized contributor to atmospheric pollution.

In the Indian mainland, coal combustion, industrial emissions, traffic-related non-exhaust emissions (NEEs), open biomass and solid waste burning, and ship emissions are primary sources of atmospheric Pb. While Pb emissions from coal-fired power plants have declined due to regulatory interventions, uncontrolled biomass and waste burning continue to pose significant risks. Vehicular emissions, including both exhaust (EEs) and NEEs such as brake wear and tire wear, contribute substantially to urban road dust Pb levels. Isotopic evidence highlights that NEEs contribute nearly as much Pb as EEs. Although the shift to EVs may reduce EEs, NEEs will remain a significant concern. Projections indicate that by 2045, Pb emissions from vehicular sources will remain substantial, necessitating further regulatory action to control NEEs.

The study evaluates the efficacy of ferns, *Pteris vittata* and *Pteridium aquilinum*, in capturing and mitigating atmospheric Pb. These plants demonstrate high foliar dust capture efficiency, effectively assimilating Pb from atmospheric fallout. Pb isotopic compositions suggest that Pb in fern tissues originates predominantly from aerosols and dustfall, rather than from geogenic sources. The findings indicate that integrating ferns into biofiltration systems could serve as a sustainable air remediation strategy.