

Heavy metal contamination and ecotoxicological hazards in the agricultural soil, Pakistan

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The significance of soil being vital environmental resource cannot be exaggerated, since it offers a variety of ecosystem amenities and sustains agricultural practices. However, contamination of soil can negatively impact agricultural services, productivity, and public health. The presence of heavy metals (HMs) in soil poses a significant risk to human health and living organisms because of their toxicity, ability to bio-accumulate, and persistence in the environment. This research focuses on HMs contamination in agricultural soils of Pakistan, examining on distribution patterns, ecological risk, and the potential implications for human health. The contamination factor, geo-accumulation index (Igeo), and integrated indices, including the spatial distribution of the ecological risk index were calculated based on HMs concentrations. Likewise, the Igeo values were noted in the following way: Sindh > Baluchistan > Punjab > Khyber Pakhtunkhwa > Gilgit-Baltistan > Islamabad. Similarly, the province of Punjab, Khyber Pakhtunkhwa, and Islamabad territory exhibited higher mean ecological risk levels ($160 < \text{ERI} < 320$), primarily because of cadmium (Cd). The non-carcinogenic risk, measured by hazard quotient, was shown to be elevated for children of Punjab (1.59) owing to arsenic (As) ingestion, while a diminished risk was noted for adults in Punjab from inhaling zinc (Zn) ($2.5\text{E}-08$). Additionally, soil exposure to (As) (1.61) had a higher health index (HI) than the other HMs. Furthermore, the determined cancerous risk remained within the permissible limits (10^{-4} – 10^{-6}). This research emphasizes that continuous monitoring of HMs pollutants in soil is necessary, particularly in the provinces of Sindh, Baluchistan, and Gilgit-Baltistan.

Keywords: Contamination; Ecological risk; Health risks; Heavy metals (HMs); Pakistan; Soil

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