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Hydrogeochemical assessment and potential nano-enabled remediation of groundwater in the copper mining region Khetri, Rajasthan, India.

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The presence of dangerous chemicals and poisonous heavy metals in groundwater is the biggest concern for the environment and society. These metals can have detrimental health effects on humans when consumed through contaminated drinking water. However, scant attention has been given to quantitatively and qualitatively analyzing groundwater used for drinking in many places in India. Our study focuses on analyzing groundwater heavy metal contamination and health risk assessment of Khetri, Rajasthan, India. We have analyzed 60 ground water samples for Pb, Cu, Cd, Cr, and Fe using atomic absorption spectrometry (AAS) that were collected during the monsoon and post monsoon seasons. We found elevated values EC, TDS, anions (fluoride, nitrate and sulphate), cations (sodium, calcium, magnesium) and heavy metal like Pb, Cd, Fe and Cr, 100% surpassing the limits set by WHO in both the seasons but comparatively high concentrations found in the samples of post monsoon season. PCA clustered groundwater's physicochemical properties and heavy metals. IDW interpolation showed the spatial distribution of heavy metals, while Hydrogeochemical Facies diagrams (Durov & Piper) indicated chloride and sulphate abundance. Consuming metal-rich groundwater poses high noncarcinogenic and environmental risks, primarily due to Cd, Fe, Pb, and Cr. Except for copper, all metals had hazard quotients (HQ) above 10, indicating high noncarcinogenic risk for adults and children. Our study shows the urgent need for remediation to ensure groundwater suitability for drinking. Building on this monitoring we propose a remediation strategy using acid-resistant materials to absorb mine leachates at the source, such as tailings. This would significantly reduce heavy metal leaching into groundwater, a major cause of water pollution in region.