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Heavy metal contamination in stream sediments and environmental impacts of artisanal gold mining in Nyema and Zingui: Land use and land cover implications

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This study investigates heavy metal contamination in stream sediments and the environmental impacts of artisanal gold mining in Nyema and Zingui, southern Cameroon, with a focus on land use and land cover (LULC) changes over the past two decades. A total of 35 placer sediments were randomly collected through panning from the stream bed, with a sampling interval of 150 meters, and subsequently analyzed using Inductively Coupled Plasma Mass Spectrometry. To examine LU/LC changes, a 20-year analysis was conducted employing integrated geochemical and remote sensing methods. Landsat imagery from 2004 to 2024 was utilized in ArcGIS Pro and ERDAS IMAGINE, applying standard pre-processing and corrections to generate land use/land cover maps. The novelty of this research lies in the integration of geochemical data with land use and land cover dynamics to elucidate the connections between anthropogenic activities and sediment contamination in this region of Cameroon. The findings reveal significant enrichment of Co, Cr, Cu, Pb, Sc, Th, U, V, and Zn compared to Upper Continental Crust standards, with Pb, Th, and Cr exhibiting the highest concentrations and variability, indicating localized contamination hotspots. Statistical analyses, including Pearson's correlation and factor analysis, suggest that these metals originate from anthropogenic sources, primarily artisanal mining and agriculture, as well as natural geogenic processes. Pollution and ecotoxicity indices confirm severe to ultra-high contamination levels, particularly for Pb, Th, and U, while ecological and toxicological risk indices indicate significant to extreme ecological risks, especially for Cr and Pb, posing potential threats to aquatic ecosystems and human health. LULC analysis (2004–2024) identified a decline in evergreen forest cover from 90% to 84.63%, with increases in cultivated land, rangeland, and built-up areas due to mining and agricultural expansion. The observed environmental impacts include deforestation, abandoned mine pits, and water pollution, necessitating targeted monitoring, source control, and sustainable land-use strategies to mitigate ecological and health risks. The findings underscore the critical need for pollution reduction and long-term land-use planning in Cameroon and other rapidly growing regions worldwide.