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Contamination Levels and the Ecological and Human Health Risks of Potentially Toxic Elements (PTEs) in Soil of Baoshan Area, Southwest China

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Abstract: The primary goals of this study were to reveal the environmental status of potentially toxic elements (PTEs) and their ecological risks, as well as their associated health risks in the Baoshan area, southwest China, which has been surveyed with the scale of 1:250,000 geochemical mapping. Based on a comparison of the PTE concentrations with the soil environmental quality of China and the enrichment factor (EF), geo-accumulation index (I_{geo}), contamination factor (C_f), and potential ecological risk indexes (E_r^i and PERI), as well as the potential non-carcinogenic hazard indices (HI and CHI) and carcinogenic risks indices (TCR and CTCR), the following conclusions were drawn: The PTE concentrations in the surface soil samples that were collected from the investigated area (1.65% sites) exceeded the risk intervention values (RIV) for soil contamination of agricultural land of China. Cadmium (Cd) and mercury (Hg) posed higher ecological risks than other PTEs (arsenic (As), chromium (Cr), lead (Pb), copper (Cu), nickel (Ni), and zinc (Zn)), which was highlighted by their toxic response factor. Arsenic was the main PTE with a non-carcinogenic risk (19.57% sites for children and 0.25% sites for adults) and the only PTE that carries a carcinogenic risk (2.67% sites for Children and 0.76% sites for adults) to humans in the research area. Children are more vulnerable to health risks when compared to adults because of their behavioral and physiological traits. Geological genesis was responsible for the high concentrations, ecological risk, and health risk distribution patterns of the examined PTEs. Even though the present research highlights several important aspects related to PTE pollution in the research area, further investigations are needed, especially in mining areas.

Keywords: soil PTEs; ecological risks; human health risks; the Baoshan area; southwest China

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1. Introduction

Soil is the foundation of food production systems and is a critical component for national food security. Soil quality has become a key concern internationally due to competing demands between people, resources, and the environment [1–7]. Specifically, the potentially toxic elements (PTEs) such as arsenic (As), cadmium (Cd), chromium (Cr), mercury (Hg), lead (Pb), copper (Cu), nickel (Ni), and zinc (Zn) in soil have received significant attention in the past few decades due to their widespread distribution and severe toxicity to plants, animals, and humans. Oral ingestion (such as unintentional/intentional hand-oral ingestion), respiratory inhalation (as dust via respiratory inhalation), and dermal contact are the main routes through which PTEs from soil can be transferred into the human body [8–13]. Excessive intake or long-term exposure to PTEs may cause adverse effects to