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Editorial

The Silent Shifting Ground: How Geo-Environmental Degradation and Elemental Toxicity Drive Hidden Danger/Hunger and Emerging Pathologies in Developing Countries: The Ghanaian Situation

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The fracturing paradigm of modern nutritional science

To the Editorial Board and Readers of *EC Nutrition* Journal: The foundational paradigm governing modern nutritional science is literally fracturing beneath our feet. For decades, public health strategies aimed at eradicating "hidden hunger" in Sub-Saharan Africa have relied heavily on standard fortification protocols, biofortification, and static dietary guidelines. However, these interventions are built upon an increasingly outdated assumption: that the soil-plant-human continuum remains chemically stable and unpolluted.

In Ghana, and similarly across many developing nations, accelerated geo-environmental degradation is fundamentally altering the elemental chemistry of our food supply. Driven by unregulated artisanal small-scale gold mining (*galamsey*), soil acidification from synthetic fertilizers, agrochemical overuse, and heavy metal leaching, the environmental geochemistry is being severely compromised. As an applied geologist, I raise this urgent caution to the nutritional community: we can no longer evaluate the human diet in a biogeochemical vacuum.

The dual danger: Essential micronutrient depletion vs. toxic metal bioaccumulation

The current crisis unfolds along a highly perilous, two-way pathway—a dynamic where malnutrition and poisoning occur simultaneously within the same food sources.

Essential depletion (The true "hidden hunger")

The loss of soil organic carbon, severe topsoil erosion, and shifting pH dynamics are actively stripping essential trace elements, such as Zinc (Zn), Iron (Fe), and Selenium (Se), from major farming belts. Consequently, staple crops like cassava, maize, and local leafy greens are rendered micronutritionally bankrupt. This profound absence of trace elements causes sickness, yet these are the exact foods dietitians recommend for dietary supplementation. If essential nutrients are absent from the soil, they cannot materialize in the crops, rendering standard nutritional prescriptions inherently ineffective.

Toxic mobilization

As essential nutrients decline, potentially harmful elements—Lead (Pb), Cadmium (Cd), Arsenic (As), and Mercury (Hg)—become hyperbioavailable. Driven by agrochemicals and mining tailings, these toxic elements saturate the cultivation environment. A devastating

natural mechanism follows: nutrient-depleted crop roots up-regulate non-specific ion transport channels in a desperate search for sustenance, inadvertently bioaccumulating toxic metals directly into edible plant tissues. The crops appear outwardly unchanged, but poison is served as food on our tables.

The geoenvironmental flow of disease: Ghanaian Geoenvironmental Drivers (Galamsey Tailings, Acidified Soils, Agrochemical Leaching, Off-gas Dust) → Essential Element Depletion (Fe, Zn, Se) AND Harmful Elements Bioaccumulation (Cd, Pb, As, Hg) → Emerging Health Outcomes.

Emerging health outcomes: A broader perspective on public health realities

In agricultural communities, this elemental mismatch manifests in atypical, severe, and systemic health crises:

- **Refractory anemia and unexplained stunting:** High rates of anemia across the middle and northern belts remain entirely unresponsive to standard oral iron therapy. Severe zinc depletion, compounded by sub-chronic Pb and Cd ingestion via staple tubers, inhibits physiological nutrient utilization, locking populations into perpetual developmental stunting.
- **Emerging toxic nephropathy:** Regions burdened by mining runoffs report alarming increases in non-communicable, idiopathic chronic kidney disease (CKD). The routine ingestion of Cd- and As-laden crops imposes persistent, low-dose renal toxicity, dangerously masking itself as metabolic failure.
- **Pediatric neurodevelopmental deficits:** Environmental lead exposure via local food crops is silently eroding childhood cognitive capabilities. This triggers reduced IQs, learning disabilities, and behavioral shifts without ever presenting acute toxicity symptoms.

Data-driven insights: Unmasking the geochemical environment

Understanding the geochemical environment is paramount to deciphering this dual-edged sword of nutritional deficiency and environmental toxicity. Natural geological variations and anthropogenically accelerated weathering determine the bioavailability of both essential and potentially harmful elements, including non-essential elements.

To ground this reality in empirical data, two vital studies underscore this crisis:

1. **Geogenic depletion (Arhin., *et al*. 2022):** Investigations into stream sediment geochemistry in the Bono East Region demonstrated that natural geogenic depletion creates profound micronutrient deficits, exposing agricultural communities to chronic dietary selenium deficiencies.
2. **Toxic Mobilization (Arhin., *et al*. 2019):** Conversely, in the mining-impacted Wassa area of Southwest Ghana, the intensive weathering of sulfide minerals releases toxic trace elements like arsenic and lead into surrounding soils and drainage systems. Unchecked, these hidden hazards migrate seamlessly through local water supplies and food crops.

Together, these findings prove that the regolith acts simultaneously as a silent reservoir of toxic hazards and a root cause of trace element starvation.

Conclusion and a Call to Action

Operating in disciplinary silos is no longer viable. Modifying dietary habits alone is vastly insufficient to resolve the latent nutritional deficiencies and toxic threats of the modern era. Nutritional safety and public health strategies must be directly informed by spatial geochemical mapping.

If nutritional science continues to prescribe dietary interventions without analyzing local geoenvironmental chemistry, these interventions are destined to fail. I call upon the nutritional, medical, and public health communities to embrace an interdisciplinary alliance with medical geologists and geoenvironmental scientists by implementing the following immediately:

1. **Mandate geoenvironmental dietary profiling:** Systematically integrate soil and water toxicological mapping into all national nutritional surveys.
2. **Redefine micronutrient interventions:** Transition away from simple deficiency models toward holistic frameworks that evaluate exact Nutrient-to-Toxic Element Ratios in local food supplies.
3. **Pioneer agro-environmental nutrition:** Forge active collaborations with biogeochemists, agronomists, and environmental epidemiologists to remediate soils and protect crop safety at the fundamental root level.

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