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Spatial relationships between contaminated mining areas and pathological states around Kadoma, Zimbabwe

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Toxic element released from mining into agro-ecosystems pose a serious threat to the health of communities that continue to reside in surrounding environments well after the cessation of mining activities. In Zimbabwe the issues of agricultural land contamination through mining activities, the extent of contamination, toxic element migration pathways and routes of human exposure, are poorly understood. This is because few medical geology or environmental geochemical studies and mapping programmes have been undertaken to date, and even fewer studies researching the direct link between toxic geological elements and human health. Once these data are accrued, research studies into improved remediation techniques and use of novel methods such as phytoremediation, can then be designed to address the contamination issues. Such research studies rely heavily on the ability to look into spatial relationships that exist between contaminated mining areas and the diseases or pathological states that are known to be linked with certain toxic elements.

This study produced geochemical maps for highly mineralised, heavily mined areas in Kadoma, Zimbabwe. Georeferenced soil, stream sediment and water samples were collected and analysed for the concentrations of 53 elements that included arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc. Areas of known abandoned and active mine facilities were identified and digitised from satellite imagery and through field mapping.

Spatial analyses of the background geology, geochemical mapping and data from the Ministry of Health on reported cases of chronic illnesses within the area revealed that there may be a link between geological material and pathological states. Initial results are thus indicative of mining activity being linked to the elevated cases of chronic renal failure, chronic heart failure, mental illnesses and still births.

Maps produced through contouring and surface modelling techniques using geographical information system (GIS) applications revealed areas of significant soil and water contamination in the vicinity of the major mining areas with locations having levels of toxic elements well above the recommended Food and Agriculture Organization/ World Health Organization (FAO/WHO) maximum levels. Most soils around the mines have arsenic values with two digits (96.7, 81.3, 31.1, 91.6, 21.9, 30, 31.6 ppm). Total chromium values in the soils were also high (up to 406 ppm) with further analysis required to determine the chromium form in question as this has an impact on toxicity (hexavalent chromium is considered highly toxic). Though the concentration of key elements in most water samples (surface and borehole water) were below the recommended WHO guidelines for safe drinking water, some streams were found to have high arsenic values (166, 142 and 5847 ppb) compared to the recommended 10 ppb. The study also considered the level of element concentrations in common vegetables grown for consumption on these soils and found tomato fruit and pumpkin leaves showing lead levels over 200 times above the FAO/WHO recommendation.

Though the spatial resolution of certain datasets in particular the health data was course the study revealed the extent to which an integrated analysis of elevated toxic element levels can be traced to the effect on the cultivable potential of land used for food crops and how this creates an exposure pathway for entry into the food chain. The study demonstrates the need for accrued health dataset to be made spatially intelligent. It also points out the potential of spatial statistical analysis of health, geology and geochemical data in providing information for use in future health risk assessment campaigns.

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