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Assessing health risks at a Soviet-era mercury mine: validation of X-ray Fluorescence (XRF) for humanitarian intervention in the Kyrgyz Republic

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Khaidarkan town in Batken Province, Kyrgyzstan is home to one of the world's largest and last primary mercury mines and smelters. Doctors without Borders (MSF) and the Ministry of Health (MOH) of Kyrgyzstan identified elevated rates of non-communicable diseases (NCD) in Batken, citing heavy metals as a likely factor. TerraGraphics International Foundation (TIFO) partnered with MSF and MOH to conduct a human health risk assessment to investigate heavy metal exposures. Relying on hand-held X-ray fluorescence (XRF) for soil screening enabled the team to collect hundreds of data points at a fraction of the cost of bench-scale methods. Real-time vapor mercury readings were also taken using a Lumex at soil surface to guide screening activities. To establish a site-specific mercury conversion factor between XRF and Atomic Absorption Spectrometry (AAS), soil samples were analyzed by XRF in three stages: *in situ*, *ex situ-bulk*, and *ex situ-sieved*. The *ex situ*-sieved samples were also analyzed by AAS. Results indicate that *in situ* XRF readings can be used as a qualitative tool for screening, and a conversion factor of 1.7 was most appropriate for converting *ex situ*-bulk/*ex situ*-sieved to AAS mercury results. XRF, Lumex, and AAS results identified arsenic and antimony, not mercury, as significant contributors to human health risk. Arsenic and antimony soil contamination was identified as a significant route of exposure, especially for young children. Local vegetables grown in contaminated soils were also a significant risk for this group. Results from XRF and AAS were used to inform risk intervention activities. The XRF-AAS comparison validates the use of XRF as a rapid, cost-effective monitoring tool for mercury soil contamination.
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