Risk assessment of heavy metals in a smelter town Alaverdi, Armenia

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Study objectives & Methods

• Assess arsenic (As) and lead (Pb) contamination in residential soil in Alaverdi smelter town examining its relationship with geographic proximity to the smokestack

• Estimate blood lead levels (BLL) of children using the Integrated Exposure Uptake Biokinetic (IEUBK) model

• 271 soil samples in-situ via XRF analyzer (INNOV-X α-2000)

• Distance from the smokestack and each sampling point was calculated via Arc GIS 10.2

• Elevation was derived from the geographic coordinates and categorized into two levels: above and below 900m
Alaverdi Community
Map of Arsenic Concentration

Maximum Allowable Concentration for Arsenic - 12 mg/kg
Clean-up level for Arsenic - 100 mg/kg

Arsenic concentration (mg/kg) Arsenic gradient (mg/kg)
- 16 23 - 69
- 17 - 50 70 - 120
- 51 - 100 121 - 171
- 101 - 500 172 - 222
- 501 - 1064 223 - 273
- Roads 274 - 324
- Main Rivers 325 - 1,052

Smokestack

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Map of Lead Concentration

Maximum Allowable Concentration for Lead - 400 mg/kg
Clean-up level for Lead - 400 mg/kg

Lead concentration (mg/kg) Lead gradient (mg/kg)
- 13 - 399 17 - 81
- 400 82 - 170
- 401 - 800 171 - 272
- 801 - 1600 273 - 361
- 1601 - 3703 362 - 451

Source: EPA

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Results & Conclusion

• 75.6% all soil samples exceeded the cleanup level for As and 24.0% for Pb
• Geometric mean (GM) of As decreased by 1.8 times for each km distancing from the smokestack fixing the elevation (95% CI= 1.4-2.2, p<0.00)
• GM of As decreased by 1.2 times for altitudes above 900m, while controlling for the distance from the smokestack (95% CI= 0.8-1.5, p=0.082)
• GM of Pb decreased by 1.5 times for each km distancing from the smokestack fixing the elevation (95% CI=1.2-1.9, p=0.001)
• GM of Pb decreased by 1.5 times for altitudes above 900m, while adjusting for the distance from the smokestack (95% CI= 1.3-1.8, p=0.003)
• The IEUBK model estimated BLL to be 2.7-5.1µg/dL for 0.5-7 year old children
  • Actual BLL among 4-6 year old children 3.5-24.0 µg/dL