Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AGE04-05 会場:102B 時間:5 月 20 日 15:15-15:45

Geostatistical Modeling of the Spatial Distribution of Soil Arsenic around a Smelter: From Sampling to Remediation

Geostatistical Modeling of the Spatial Distribution of Soil Arsenic around a Smelter: From Sampling to Remediation

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For almost 100 years, the Asarco Company operated a copper smelter in Tacoma, Washington State. Air pollution from the smelter settled on the surface soil over more than 1,000 square miles of the Puget Sound basin. As part of the Tacoma Smelter Plume project, there have been a number of studies looking at soil arsenic contamination, leading to the collection of more than 5,000 soil samples over the years. In 2009, the State of Washington received a settlement from Asarco, including a lump sum to pay for partial cleanup. The present study aimed to pool all of the sampling results to create a model that can be used to further prioritize areas for additional sampling and remediation since not enough money is available to clean all parcels.

A simulation-based approach was first developed to: 1) incorporate wind rose information, elevation, proximity to the smelter and field measurements in the geostatistical mapping of arsenic concentration estimates at the residential parcel level, and 2) compute the probability of exceeding specific arsenic levels at the parcel and block-group levels. Results indicate higher arsenic concentrations on undeveloped parcels, closer to the smelter and along the prevailing wind directions. The simulation-based approach also allowed the computation for each block-group of the expected number of parcels where a given arsenic concentration threshold is exceeded with a minimum probability. This information will be used to select widely contaminated block-groups where all parcels will be systematically sampled and the ones exceeding a target threshold (e.g. 90 or 100 ppm) will be remediated.

A design simulation study was conducted to compare the power of different composite sampling design options when deciding whether the average arsenic concentration within a residential parcel exceeds or not decision criteria of 90 or 100 ppm. The expected rates of false positives and false negatives were computed for six different sampling design options that included: composite samples at 4:1, 6:1, 8:1, 10:1, and 12:1, as well as an MIS design at 30:1 for comparison purposes. Based on the power curves and field practicability/cost issues, the 8:1 composites were selected by the local agency.

キーワード: sampling design, remediation, interpolation, pollution, soil arsenic
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