

Project Proposal 0

Yuehui Gong

What is the spatial distribution of toxic metal concentration in soil and its change over time?

Proposal: Mapping and modeling toxic metal concentration in soil based on multi-spectral images and environmental variables

Industrial activities and sites are great contributor to soil contamination and toxic metal concentration. In addition to the incomplete sampling data, remote sensing provides a new opportunity to model and detect the toxic metal concentration in soil over time with the incorporation of geographic and environmental attributes.

Spectral Indices and Environmental Factors:

Spectral indices (clay mineral ratio = $\text{Band6}/\text{Band7}$, normalised vegetation index = $(\text{Band5} - \text{Band4})/(\text{Band5} + \text{Band4})$, Greenness, Wetness...), which are generated from bands of satellite image, could be used to reflect the soil properties associated with heavy metals distribution. Besides that, environmental attributes like precipitation, elevation, aspect, slope, water flow and distance to brownfield can also impact the soil and vegetation conditions and can be included in the model.

Spatial modeling and calibration:

Toxics release inventory database by EPA has covered the chemical data of the soil samples taken from monitoring sites. These separated metal sample data could be used for model calibration and validation. (Cubist tool or GA-BP model are used in relevant research)

How will this be used:

Once a user inputs the latest parameters including satellite image bands, precipitation, temperature and other real-time data, the model built could be used to visualize the real-time spatial distribution of toxic metal concentration in soil and to identify areas in a higher risk of soil contamination and its change over time,

(Continuous calibration based on soil samples' chemical data might be needed.)

Deliverable:

The final deliverable of this study can be a research paper or a GIS tool.

Reference article:

Estimating the heavy metal concentrations in topsoil in the Daxigou mining area, China, using multispectral satellite imagery: <https://www.nature.com/articles/s41598-021-91103-8>

Digital Mapping of Toxic Metals in Qatari Soils Using Remote Sensing and Ancillary Data: <https://www.mdpi.com/2072-4292/8/12/1003/htm>

Modeling the distribution of heavy metals in lands irrigated by wastewater using satellite images of Sentinel-2: <https://www.sciencedirect.com/science/article/pii/S1110982321000223#f0025>

Datasets:

Landsat 8: U.S. Geological Survey - USGS.gov

Superfund Enforcement Cleanup Work Sites:

<https://www.epa.gov/enforcement/map-superfund-enforcement-cleanup-work>

Toxics Release Inventory Database (TRI facilities, 2000-2021, annually)

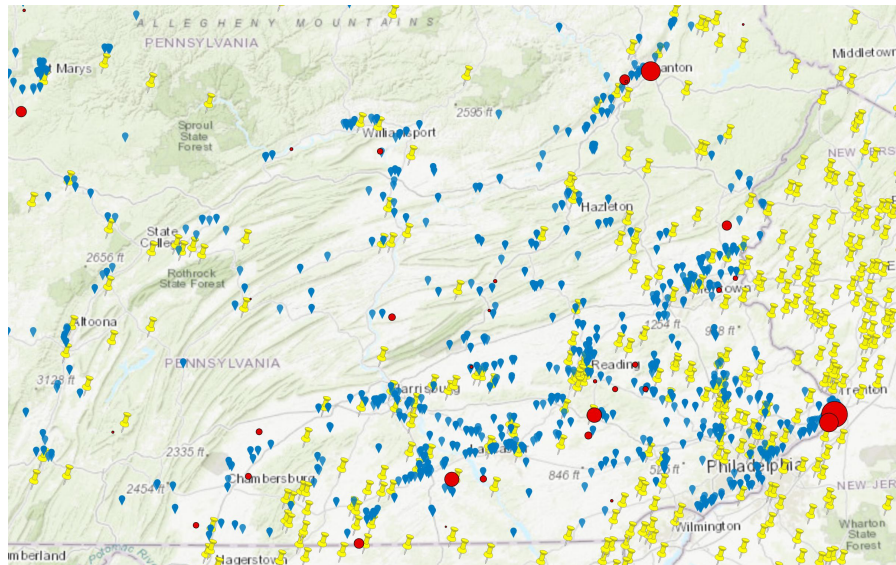
https://enviro.epa.gov/facts/tri/form_ra_download.html

Landfill Sites List: current status/ waste amount

<https://www.epa.gov/lmop/project-and-landfill-data-state>

Precipitation/ Temperature based on monitoring station (2000-2021, monthly)

<https://www.nci.noaa.gov/data/global-summary-of-the-month/>



Monitor facilities data sample (Red: Landfill Sites; Blue: Toxics Release Inventory Database for soil sample data; Yellow: Monthly Precipitation/ Temperature)



Satellite image sample (Landsat 8 - Band 5)