Evaluation of Lead Migration at Public Shooting Ranges in Arkansas

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Introduction

One of the main considerations of managing a shooting range is the impact of lead (Pb) bullets at these sites. An important aspect of protecting environment and human health is ensuring efforts to sequester the erosion of Pb from shooting ranges.

Though insoluble in its metal form, at typical surface conditions, Pb can oxidize into hydrocerussite ($Pb_3(CO_3)_2(OH)_2$, which can be dissolved and release Pb if soils and meteoric waters are at a specific pH. This form of lead can migrate from runoff resulting from precipitation.

Two public firing ranges in Arkansas, Site 1 and Site 2, were selected for sampling and geochemical analysis of their soils in their shooting range and drainages.

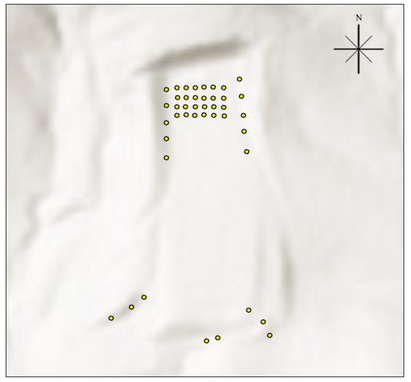
Site 1 is located on a calcareous siltstone formation, producing lightly vegetated silty soils with rock debris throughout. Site 2 is located on a quartz rich sandstone formation, producing fine sand soils with abundant grasses and other vegetation.

Methods

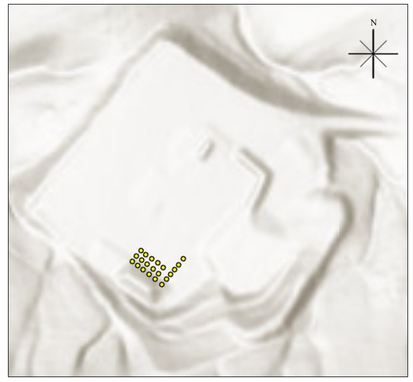
Soils at Site 1 and Site 2 were collected along 15 ft intervals, progressing away from the berms towards the shooting stands. 42 samples were taken at Site 1, and 21 samples were collected at Site 2. Samples were also taken along lateral and terminal drainage areas at the properties, where evidence of erosion and standing water were present.

After collection, the soil samples were dried, sieved to remove rock debris, bullet material, and organics, and were transferred into cups for analysis. A pXRF was used for geochemical analysis of the soils, focusing primarily on Pb concentrations.

Results

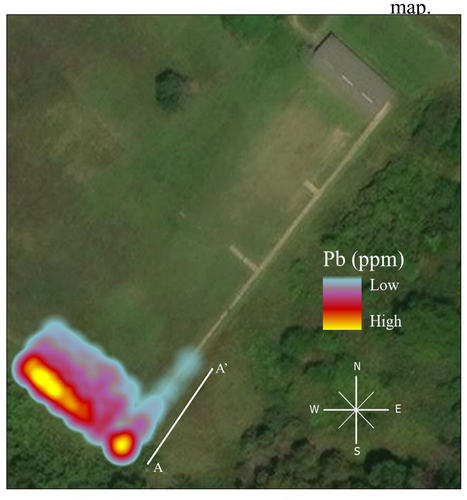


Site 1 LiDAR imagery.



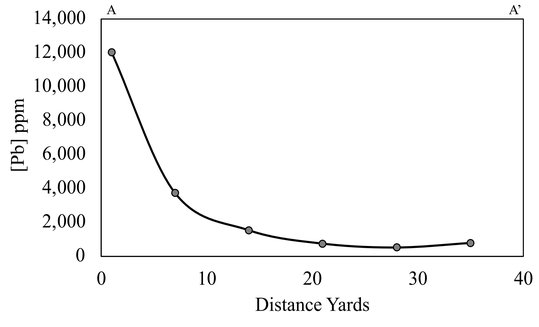
Site 2 LiDAR imagery.

Site 1 overview and soil Pb heat map.



Site 2 overview and soil Pb heat map.

Despite decreasing trends, minimum Pb values still exceed the background Pb concentration of 47 ppm.



Site 1 and Site 2 contained relatively high concentrations of Pb at the berms, with concentrations tapering downwards away from the berms.

- Site 1: Max Pb = 8,266 ppm
- Site 2: Max Pb = 12,023 ppm (1.2%)

Along the drainage channels, Pb concentrations remained elevated relative to the background concentrations.

Conclusions

- Lead concentrations appeared to respond to each sites' specific topography, soil, and vegetation.
- Both sites had measurable Pb migration along their drainages, indicating that Pb was moving away from the berms.
- High vegetated cover in ranges appear to inhibit Pb movement from the berms and could help reduce the amount of Pb that reaches the drainages.
- These sites suggest that is is worthwhile to monitor sites for continued Pb migration, and to tailor management practices to each site's conditions.

Future Directions

- Investigating soil Pb concentration over time would assist in determining if the problem is ongoing or from an isolated event.
- More comprehensive sampling would allow a more complete analysis of site characteristics and transport mechanisms.