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Detection and Monitoring of E-Waste Contamination through Remote Sensing and Image Analysis

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Electronic waste (e-waste) is one of today's fastest growing waste streams, and also one of the more problematic, as this end-of-life product contains precious metals mixed with and embedded in a variety of low value and potentially harmful plastic and other materials. This combination creates a powerful incentive for informal value chains that transport, extract from, and dispose of e-waste materials in far-ranging and unregulated ways, and especially in settings where regulation and livelihood alternatives are sparse, most notably in areas of India, China, and Africa. E-waste processing is known to release a variety of contaminants, such as heavy metals and persistent organic pollutants, including flame retardants, dioxins and furans. In several sites, where the livelihoods of entire communities are dependent on e-waste processing, the resulting contaminants have been demonstrated to enter the hydrological system and food chain and have serious health and ecological effects.

In this paper we demonstrate for the first time the usefulness of multi-spectral remote sensing imagery to detect and monitor the release and possibly the dispersal of heavy metal contaminants released in e-waste processing. While similar techniques have been used for prospecting or for studying heavy metal contamination from mining and large industrial facilities, we suggest that these techniques are of particular value in detecting contamination from the more dispersed, shifting, and ad-hoc kinds of release typical of e-waste processing. Given the increased resolution and decreased price of multi-spectral imagery, such techniques may offer a remarkably cost-effective and rapidly responsive means of assessing and monitoring this kind of contamination.

We will describe the geochemical and multi-spectral image-processing principles underlying our approach, and show how we have applied these to an area in which we have a detailed, multi-temporal, spatially referenced, and ground-validated inventory of several hundred e-waste processing and disposal sites. We have compiled these data in recent years using field observation, interviews with e-waste workers, and systematic manual inspection of high resolution ortho-photo imagery (Garb and Davis, 2015). Drawing on this inventory, we offer a proof-of-concept demonstration of an image-processing algorithm that can reliably detect such sites. We will also discuss several ways in which we are extending this research. One of these is testing our ability to scale up and apply this approach to similar contamination sites in other geologic contexts. Relatedly, drawing on our extensive chrono-sequence of sites with differing contextual and use characteristics, we are exploring the factors shaping if and how certain soil types and/or local and regional mineral assemblages retain heavy metal contaminants more strongly (and for longer periods of time) than others, or whether these factors mediate contaminant transport.