D24 Remote Detection of Clandestine Graves: A Comparison Across Ecosystems

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After attending this presentations, attendees will gain an understanding of the use of remote sensing for detecting clandestine graves across a range of ecosystems. The fundamental concepts of remote sensing utilizing the reflectance of solar radiation are presented as applied to forensic investigations of clandestine graves.

This presentation will impact the forensic science community by demonstrating how imaging spectroscopy can be used to detect the spectral signature of subsurface cadaveric decomposition in a range of ecosystems. This technology goes beyond the simple detection of "disturbed soil" and illustrates how cadaveric decomposition affects the reflectance of soils in a similar way in varying ecosystems from tropical to temperate.

Remote sensing in the earth and planetary sciences is a well developed field with several proven applications in geology, forestry, ecology, marine sciences, defense and security, biogeochemistry, and agriculture and soil sciences among many others. The transfer of this technology to forensic investigations has been relatively recent. This form of remote sensing utilizes solar radiation to infer characteristics about the Earth's surface. The solar radiation reflected from the surface to field-portable, airborne and satellite sensors is recorded across of range of hundreds of narrow, discrete wavelengths of light. Specific patterns in this reflected radiation (i.e., spectral signatures) can be used to determine the nature of the material or objects on the Earth's surface or in more precise studies to identify individual targets such as vegetation types, vegetation health, mineralogical compositions, and water content of soils, among many other others.

For several years, a critique of this technology had been that "generic" disturbances in the soil would lead to several false positives in the detection of clandestine graves, which, from a solely contextual perspective, such as the interpretation of aerial photos resemble other forms of disturbance. In these critiques; however, the spectral information from the hyperspectral domain was often neglected.

The potential of differentiating the reflectance of subsurface cadaveric decomposition from generic soil disturbance in a seasonal tropical environment has been recently shown in the literature from field spectroscopic and airborne imaging spectroscopy.

This research is part of an ongoing interdisciplinary research program investigating the detection of clandestine burials across ecosystems. A comparison in the similarities of the spectral signatures from field and airborne imagery across contrasting ecosystems: tropical seasonal (distinct dry season with no rain), tropical rain forest (limited dry season and overall precipitation in excess of 4m), and temperate (distinct summer and winter with freeze-thaw cycles). In each ecosystem the graves examined are animal proxy graves, encompassing a wide range of species from cattle in the tropical systems to elephant, zebra, buffalo, and several unknowns in the temperate environment. Additionally, a broad temporal range in the ages of the graves from one week to over six years at the time of data collection.

Each of the graves consisted of one to several bodies interred in soil. The spectral signatures of the graves differed from reference non- grave soils and "disturbed" soil in each environment. Furthermore, similarities in the spectra of the grave soils were observed across environments indicating that subsurface cadaveric decomposition alters the soil reflectance in similar ways in different ecosystems with different soil types, climates, and ages of the burials, and species compositions. Physical soil chemical composition and temperature, vegetation reflectance and vegetation pigment concentration data corroborate the findings from the soil spectral data. The similarities in the spectra of the graves from the various ecosystems can be used to further develop detection methodologies that can be applied to airborne or satellite imagery.

Remote Sensing, Clandestine Graves, Detection