D14 Hyperspectral Remote Sensing of Individual Grave Sites — Cadaver Decomposition Chemical Effect on Spectral Vegetation and Soil Changes

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After attending this presentation, attendees will gain an understanding of airborne hyperspectral remote sensing as it pertains to locating new and recent clandestine grave sites including known limitations and areas in need of further investigation. The presentation will also cover the effects of cadaver decomposition chemicals on the spectral signatures of soils and vegetation, the changes which occur over time, and how these results can be utilized for detection of clandestine and unknown grave sites.

This presentation will impact the forensic science community by outlining a potential nondestructive tool for the detection of recent individual grave sites using airborne platforms and through relatively rapid assessment to narrow down search areas and prioritization, enabling law enforcement personnel or Search and Rescue to cover a wider area than is possible using ground-based detection methods such as ground-penetrating radar and cadaver dogs.

The use of hyperspectral remote sensing for the detection of clandestine graves is emerging as a potential alternative tool in forensic investigations. Previous studies have demonstrated that it is possible to use hyperspectral remote sensing techniques to detect both mass and single graves. With this multi-year study, the goal is to demonstrate the feasibility of utilizing this same technology for the detection of recent individual burial sites under a wider range of conditions.

Detection of clandestine burials is of interest to police and first responders, with cases arising from victims of crime as well as situations such as missing hunters and hikers where no foul play is suspected. Finding buried bodies can be crucial to solving cases, as well as for providing closure for victims' families. Airborne hyperspectral remote sensing enables coverage of a wider area than is possible using ground-based detection methods. However, as with all detection technologies, it has its limitations and a fundamental aspect of using this technology for single grave detection is to understand what these limitations are.

Detection is based on the alteration of the environment by the body through decomposition, essentially a form of environmental contamination which can affect both the soil and the vegetation. It is known that a decomposing body alters the surrounding environment and that the changes in the soil matrix can alter plant chemistry. The degree to which this alteration takes place is highly dependent on season, geographical location, vegetation type, and the state of the body when it is buried, as well as characteristics of the body such as the weight. Due to the chemical changes in the soil, plants undergo a stress response, changing the levels of plant pigments. These changes in plant pigments have been shown to be detectable by hyperspectral sensors. The detection of single graves poses a difficult detection problem primarily because the body mass is relatively small and the effects of the decomposition will be limited spatially. Furthermore, several environmental effects may also induce similar spectral responses. However, these responses are generally on a larger spatial scale.

For this study, 20 pig (*Sus scrofa*) carcasses were utilized as proxies for human cadavers. This research examined the effects of three burial scenarios — surface, 30cm, and 90cm soil cover (all with and without the bodies being wrapped in garbage bags) — on the detectability of single bodies (180-200lbs each) from an airborne sensor as well as from laboratory analyses of the spectral signatures of the soil and vegetation. An aircraft equipped with hyperspectral sensors covering the visible-to-shortwave infrared range (450-2500nm) sensors collected imagery as time and weather permitted over the course of three years (2011-2013). In addition, a FieldSpec® 3 Portable Spectroradiometer was used to collect vegetation spectra in the field and soil spectra in the lab.

Soil samples were collected three times monthly during the first year, with two samples in the growing season collected in the second and third years. These underwent aqua regia digestion for element analysis. Chlorophyll and carotenoid values were extracted from the vegetation samples to quantify vegetation pigment differences between background and disturbed soil vegetation.

This study found that burial depth plays a significant role in the detectability of individual bodies based on changes in the soil and vegetation that were especially noticeable shortly after burial. The majority of the spectral changes that were detectable through airborne and handheld sensors in the first year indicated an overall disturbance effect rather than a direct effect on the soil and vegetation from the

Copyright 2014 by the AAFS. Unless stated otherwise, noncommercial *photocopying* of editorial published in this periodical is permitted by AAFS. Permission to reprint, publish, or otherwise reproduce such material in any form other than photocopying must be obtained by AAFS. ** Presenting Author* decomposition chemicals from buried remains. In the second and third years, the effects of the cadaver decomposition chemicals were more apparent in the spectral changes.

This presentation will highlight what this study means for using this technology and will illustrate situations in which these tools are feasible for improving detection rates of clandestine graves as well as describe the detailed calibration procedures that are required in order to adequately use such data to locate the graves.

Hyperspectral Remote Sensing, Cadaver Detection, Clandestine Graves

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