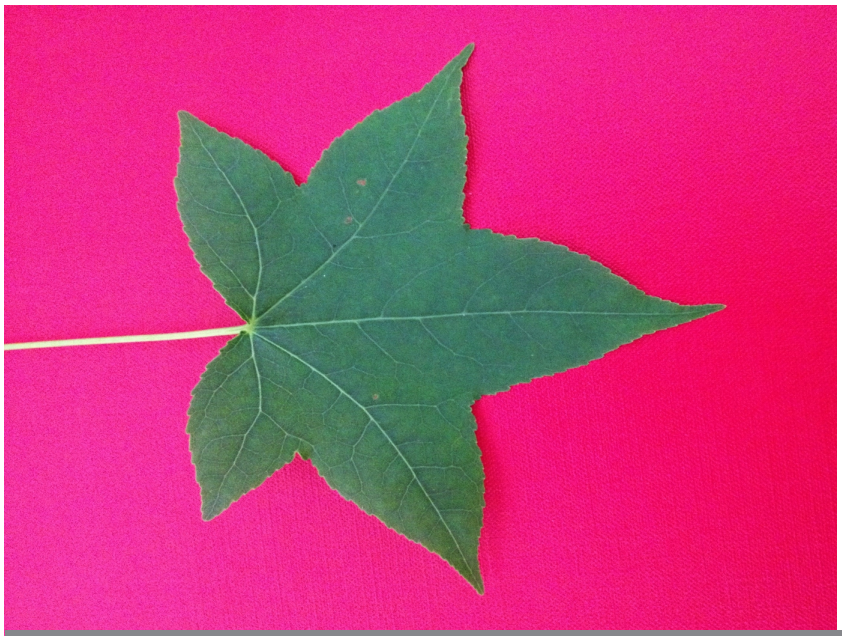


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Environment

Tool for Rapid Identification of TCE in Plants

Hyperspectral Estimator for Site Characterization and Monitoring

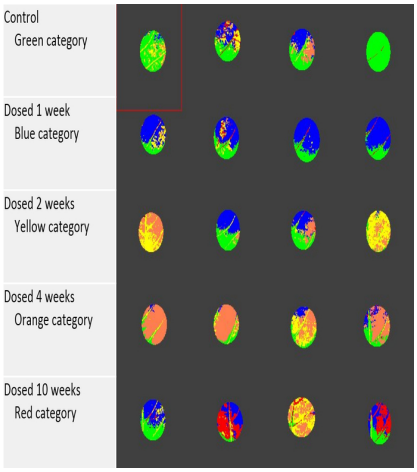
In collaboration with the State University of New York and the Naval Research Laboratory, NASA Marshall Space Flight Center is developing a hyperspectral estimator to detect trichloroethylene (TCE) in plants. TCE has been a widely used industrial solvent known to be toxic to humans and animals. Although its use and disposal have become more restricted in recent years, TCE is one of the more prevalent groundwater contaminants in the United States. Current methods exist to identify the locations of TCE at contaminated sites; however, these methods typically require destructive sampling techniques as well as time-consuming and expensive laboratory analysis. In contrast, the hyperspectral estimator is being designed as a nondestructive, quick, and lower-cost way to screen for TCE across large areas. It works by using spectral signatures to determine the presence/absence of TCE in the leaves of plants that may have absorbed the contaminant from surrounding groundwater.

BENEFITS

- Nondestructive: can scan the surface of a leaf without damaging the plant, unlike methods that require the removal of a core from a tree or destruction of other parts of the plant
- Fast: is anticipated to provide a near-real-time presence/absence estimate for TCE, unlike current methods that typically require samples to be collected in the field, transported to a laboratory, and processed/analyzed in the laboratory
- Inexpensive: is anticipated to be less expensive than current methods that require samples to be transported to and processed in a laboratory
- Versatile: is anticipated to work on a variety of plant species

THE TECHNOLOGY

Plant uptake of TCE from contaminated groundwater is a well-known phenomenon. During the photosynthesis process, plants metabolize the TCE into a byproduct called trichloroacetic acid (TCAA). TCAA has been found to be a good indicator (or surrogate) molecule for the presence of TCE because it is more stable than TCE in plants. The hyperspectral estimator is being designed to detect TCAA. The method uses a white light that is directed at the surface of a plant's leaf. The interaction between the light and the leaf produces spectral signatures that are captured using a detector. A processor that will be coupled to the detector will compare these signatures to a library/database of signatures known to be indicators of the presence of TCAA (and thus TCE). The figure below on the left shows hyperspectral images captured using the method for leaves dosed with TCE over various time periods. These images are examples of response signatures that will eventually be built into the device's reference library/database. Proof-of-concept testing has shown that the hyperspectral estimator is capable of estimating the presence/absence of TCE in plant leaves with an accuracy of 80%. Efforts are now underway to further improve the accuracy of this method and to prototype the technology. The figure below on the right shows a diagram of the planned device.



Hyperspectral images captured for leaves dosed with TCE over varying time periods; these are examples of response signatures to be built into the device's reference library/database

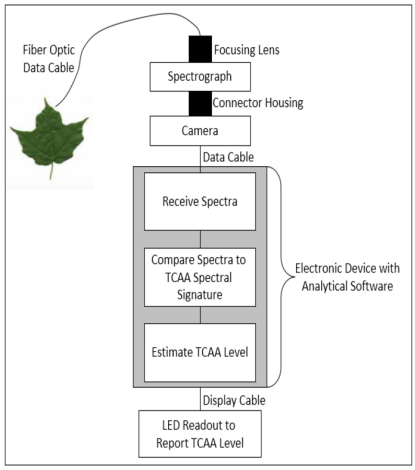


Diagram of the hyperspectral estimator

APPLICATIONS

The technology has several potential applications:

- Screening sites to determine the presence of TCE and/or to locate potential TCE hotspots at those sites
- Assessing the progress of remediation activities at contaminated sites
- Monitoring phytoremediation projects without destroying or damaging the vegetation established for cleanup activities
- Monitoring wetland health

PUBLICATIONS

Patent No: 8,564,770

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

MFS-32719-1, MFS-TOPS-53

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NP-2015-05-1802-HQ