University of Wisconsin-Madison Department of Civil and Environmental Engineering → Hydrecology Research Grou

Steve Loheide, Ph.D., Assistant Professor

Rich Deitchman M.S. student (contact – deitchman@wisc.edu, (240) 620 4551)

Eric Booth, Ph.D. student

Project Overview: A thermal remote sensing tool for detecting spring and diffuse groundwater discharge to streams

Executive Summary

This application is from the Ecosystem Engineering group at the University of Wisconsin-Madison (Department of Civil and Environmental Engineering). The purpose of this environmental research project is to improve scientific concepts of ecosystem restoration by studying and quantifying the exchange of water between groundwater, vadose water, vegetation, streams and the atmosphere (for more information on the Ecosystem Engineering group and our research see http://homepages.cae.wisc.edu/~loheide/). The research involves a proof-of-concept for using Unmanned Aerial Vehicles (UAVs) to collect thermal remote sensing data for mapping groundwater discharge. With ultra-high resolution thermal imagery, we plan to map groundwater discharge to streams to distinguish between diffuse and spring discharge. Spatial mapping of groundwater discharge and distinguishing between the two types of discharge will provide insight into the underlying groundwater flow system, identify reaches where there is spring flow through highly permeable conduits, fractures or other sources may discharge contaminated groundwater to streams and target areas where conservation or restoration may be advantageous because stream-aquifer interactions create a viable biotic habitat. The results of this research will provide a technology for proactive management of potential water pollution sources that can be controlled, minimized or eliminated.

This research will provide a cost-effective, transferable methodology for mapping of springs, which fulfills a priority set forth by the Wisconsin Department of Natural Resources in support of 2003 Wisconsin Act 310. The DNR is required by law to review proposed wells that may impact a spring where a spring is defined as "an area of concentrated groundwater discharge occurring at the surface of the land that results in a flow of at least one cubic foot per second at least 80 percent of the time." Currently, no simple or cost effective methodology exists for conducting necessary spring inventories. Our methodology provides a technique that has the potential to be a solution for conducting quick and reliable spring inventories throughout Wisconsin with the possibilities for national coverage.

Thermal remote sensing data will allow us to construct longitudinal profiles of groundwater temperature and discharge that can aid in understanding regional groundwater flow

systems. Thermal data may provide a simple means to analyzing groundwater discharge and creating conceptual groundwater flow models that can be beneficial to water resource managers. Mapping of stream-aquifer interactions leads to a greater understanding of watersheds that can aid water quality monitoring, assist conservation efforts and lead to healthier streams.

Loheide and Gorelick (2006) presented a new method to quantify groundwater discharge and hyporheic exchange that relies on a detailed spatial and temporal signature of the stream using airborne thermographic imagery. Loheide and Gorelick (2006) concluded that a change in the heat budget of a stream in California was the result of increased diffuse groundwater discharge. They successfully quantified groundwater discharge to a mountain stream in the Sierra Nevada, California using thermal remote sensing. We plan to follow the methods of Loheide and Gorelick (2006) however our airborne platform will be a UAV, as opposed to a helicopter.

Currently, the Federal Aviation Administration (FAA) is reviewing our Certificate of Application (COA) for the use of our unmanned aerial vehicle. It is now in the formal review stage after 2 months of editing and pre-processing. Although our vehicle is no different than a model plane, it is classified as a public aircraft because we are doing research. As a result, we must obtain FCC permission to use the standard 2.4 GHz wavelength that is commonly used by model pilots.

Emission Designator Data

Our airplane system uses a Futaba product for radio link. It is the Futaba model T6EX at 2.4 GHz. The FCC ID # is AZPTMSS1-24G. According to Futaba and FCC employee Benham Ghaffari, the emission designator data for the Futaba T6EX is classified, proprietary information. As a result, it does not appear in our experimental license application.

FAA Application Information

Certification of Application (COA) in review by FAA.

2007-AHQ-46-COA