Deploying a UAV-Based System to Identify Methane-Emitting Oil and Gas Wells

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Abstract

There are approximately 35,000 abandoned and unplugged oil and gas wells in the state of New York with no known location. Unplugged wells emit methane, a strong greenhouse gas, which has the potential to significantly contribute to global climate change and act as a pollutant chemical. We deployed unmanned aerial vehicles (UAVs) equipped with methane sensors, microfabricated atomic magnetometers (MFAMs), and light detection and ranging (LiDAR) over several control sites with known wells. We demonstrate that UAV-based magnetometer systems can successfully detect unmarked well sites using characteristic magnetic signals generated by vertical metal piping preserved in the ground. Our results show that it is possible to detect uncapped leaking wells by associating magnetic signatures with detected methane emission hotspots. In our experiments, we determined the optimal flight altitude and transect spacing for detection driven by the total field strength of the Earth's magnetic field and the height of tree canopies determined by LiDAR. Finally, we are developing a supervised training algorithm to identify wells and lower false alarms. Traditional methods of identifying oil and gas wells are costly and less powerful in acquisition of data such as using large magnetometers attached to helicopters. Our research indicates that remote sensing methods are a promising and potentially more efficient alternative for identifying and ultimately capping abandoned oil and gas wells.

Background

- Since the 1800's, levels of methane in the atmosphere have tripled and emissions from oil and gas wells contribute to over 19% of total methane levels (Bousquet et al., 2006; Frankenberg et al., 2005).
- As of 2010, only 25% of oil and gas wells were plugged (Bishop, 2013).
- New York State's Department of Environmental Conservation (NYSDEC) allocated over $25 million to initiatives that plug orphan and abandoned wells. Plugging one well ranges from $4,222 to $6,000 (Bishop, 2013); thus, funding is sufficient. Yet, only 104 of the estimated 35,000 wells were plugged as of 2016 because their locations are unknown (DEC, 2018).
- The Environmental Protection Agency (EPA) underestimates emissions from documented wells making data on undocumented wells vital (Allen et al., 2015)

Control Sites

Data was collected at a control site where the location of a well is known and the well is not covered by vegetative canopy. This control site is located at former Binghamton University Professor Jeffrey Barker's property in Binghamton, NY.

Methods

UAV (DJI Matrice Pro 600), Geometrics G858, MFAM, LiDAR

Figures 1 and 2. Magnetometry data was collected at ground height, 10 m, 20 m, and 40 m AGL.

Magnetics Data

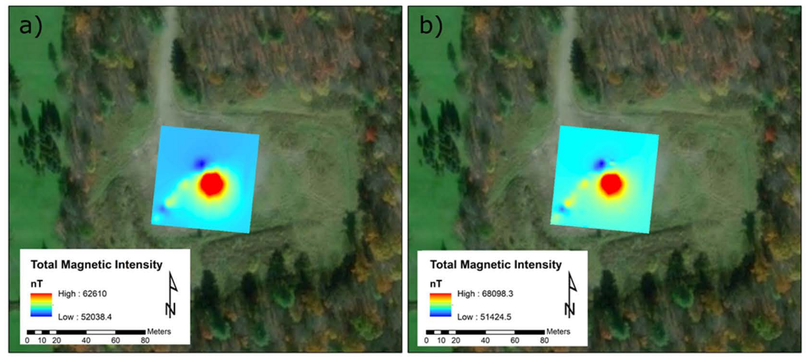

Figure 3. Magnetometry data collected at ground height. A is the magnetics data that the top sensor received and B is the magnetics data that the bottom sensor received.

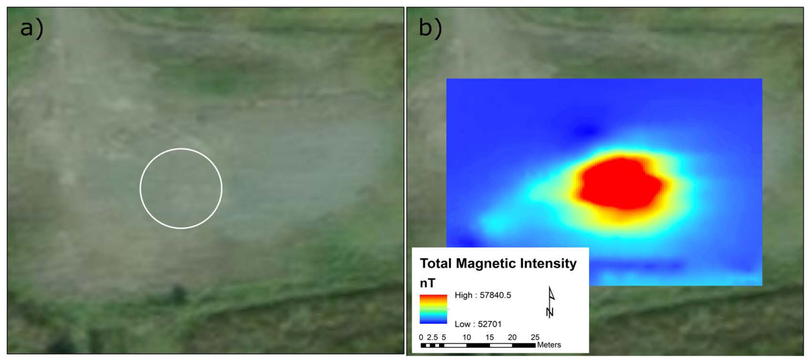

Figure 4. A is photogrammetry data and B is magnetics data collected at 10 m AGL.

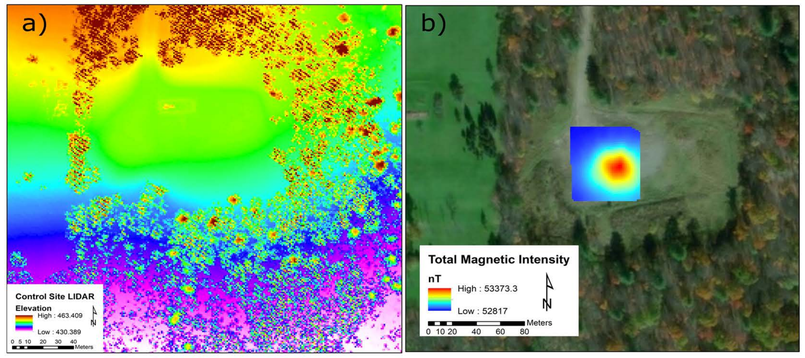

Figure 5. A is LiDAR data and B is magnetics data collected at 20 m AGL.

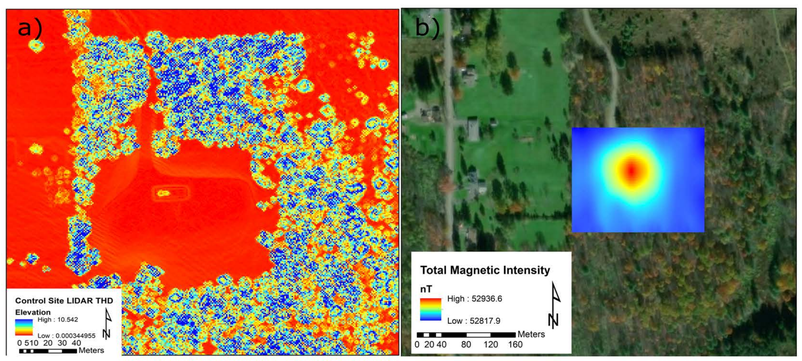

Figure 6. A is LiDAR THD data and B is magnetics data collected at 40 m AGL.

Observed Data

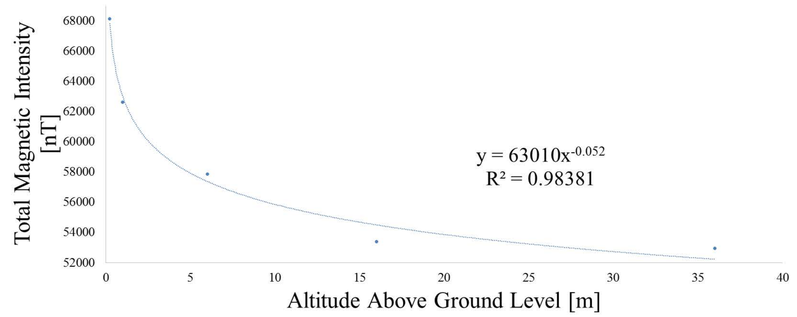

Figure 7. Results of the experimental data

LiDAR Data

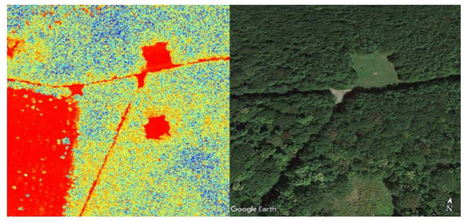

Figure 8. LiDAR data was downloaded from FEMA for three control sites where the location of a well is known. The total horizontal derivative (THD) of LiDAR data is shown on the left. Red areas show where land has been artificially flattened.

Future Work

- Attach methane sensors to the UAV-based system and fly over control site.
- Fly the UAV-based magnetometer system at 40 m AGL over control sites at Greenwood State Forest and Rock Creek State Forest where wells are located under tree canopy. Determine if our method works for wells located under tree canopy.
- Develop a supervised trained algorithm to identify wells and lower false alarms.
- Use algorithm to detect wells at blind sites across New York State.

Acknowledgements

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