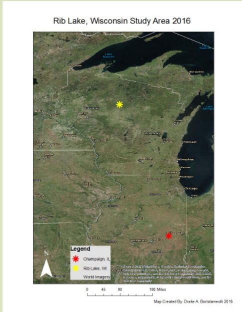
Visualizing Industrial Organic Waste Located at Rib Lake, Wisconsin: A Geospatial Perspective Ground Penetrating Radar Test

Drake Bortolameolli (UWEC) Ben Degner (UWEC) Harry Jol (UWEC) Arlen Albrecht (UW-Extension)

ABSTRACT

Rib Lake is a north-central Wisconsin village located next to a lake, which once was a holding pond for the Rib Lake Lumber Company. The company processed 1.47 billion board feet of lumber during its 70 years of operation. The sawmill employees dumped all their byproducts into the lake. The practice of dumping into Rib Lake created a thick layer of waste on the lake floor. Logs buried in the waste are of high value due to their rareness and old age. Through the extraction of the logs, the village would be able to sell them in order to fund a cleanup program.

Data was gathered from probing into the frozen lake surface. A Microsoft Excel file was created containing coordinates, depth to waste, depth to bottom of the lake and depth to potential logs for each hole. Using ESRI tools, maps were created illustrating the depth to lake bottom, location of logs and a three-dimensional rendition showing waste thickness. Using the probe information and data obtained using ground penetrating radar surveys, the data shows the thickness of waste is between 1.5 and 10 meters and the depth to the lake bottom is between 3 and 10 meters.

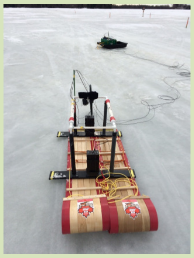


BACKGROUND INFORMATION

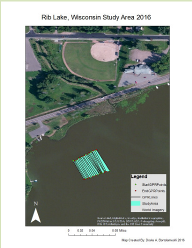
Between 1870 and 1940 much of the northern Wisconsin forests were cut and the timber was used for many different purposes-such as building infrastructures and wood furniture. Rib Lake, Wisconsin, located in north-central Wisconsin, was an important center for the lumber industry. Using the 324-acre(131 Hectare) Rib Lake as a holding pond for a lumber mill, Rib Lake Lumber Company (RLLC) produced over 1.47 billion feet of timber. Since no laws prohibited dumping industrial organic waste into the lake, the lumber company released its waste directly into Rib Lake-everything from saw dust to animal hides, over the 70 years of operation. The lake has accumulated between 3 and 10 meters of industrial waste (Jol and Albrecht, 2004). As a result, the lake is now in a eutrophic state, meaning the large amount of oxygen-using vegetation kills off the animals in the lake and severely restricts the recreational potential of Rib Lake.

METHODOLOGY

Ground Penetrating Radar (GPR) is a geospatial method, which uses electromagnetic pulses to image the subsurface. GPR is a nondestructive method that uses various frequencies on the electromagnetic spectrum. The pulses emitted from the transmitter travel through the subsurface and reflect off of different objects in the subsurface. The time it takes to travel from the transmitter to an object of reflectance and back to the receiver will determine how deep the object is.



The sled used to house the GPR equipment was a custom-built dual toboggan transport. The antennae sat in between the two toboggans, all held together and pulled across the ice by rope. The frame used to hold the equipment was constructed using PVC piping. The computing equipment was held in a secondary sled several meters behind the GPR antennae. This was done was to avoid any type of noise or interference from the electric components. The dual toboggan transport was pulled by one while the fiber optic cables connecting the antennae to the computers was support by either 2 or 3 people, and the back sled housing the computing equipment was pulled by one other individual.

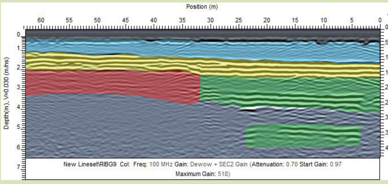


We ran 22 GPR lines across the ice each one measuring about 60 meters in length. Once reaching the end of one line all the equipment would be turned around and pulled back in the opposite direction. All lines were set so they all appear starting on the north side of the study area and going south. Our study area was a 60 meter by 60 meter grid, with spacing between each line being three meters. The frequency used was 100 MHz and we shot a pulse every 0.25 meters. The GPR profiles were then processed using PulseEKKO software at the University of Wisconsin- Eau Claire.

RESULTS

SEC Gain

Spherical Exponential Compensation: Relative reflectivity of horizons is more important



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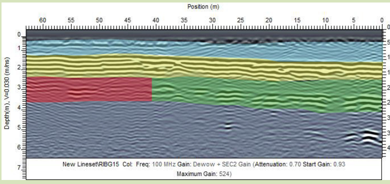

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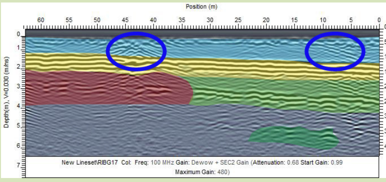

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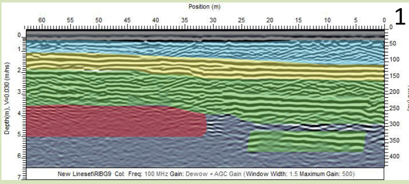
The three top profiles were processed using PulseEKKO software and SEC2 Gain, while the bottom three profiles were processed using AGC Gain. Each color represents a different geological feature in the profile. **ICE AND AIR** are represented on the tops of the profiles. In profile number 3 the **ICE** may have small pockets of water trapped within the ice causing two **DIFFRACTIONS** in places where **DIFFRACTIONS** should not be occurring. The area we were collecting data in had about 1 meter of **WATER**. Below the water is at least 1 meter of **WASTE**. This waste layer is the presumed industrial waste that the employees from the timber company dumped directly into the lake. The waste thickness is unknown because the signal was being **REFLECTED** back and forth by either the ice or water. The north sides of almost all the profiles (left) have an area of very little reflectance. This **UNKNOWN** feature could be any different feature. It could be a very absorbent material or it could be because the water is too shallow for the signal to bounce off and get reflected again. We will not know for certain unless we core into the sediment.

AGC Gain

Automatic Gain Control: Information irrespective of amplitude fidelity is important



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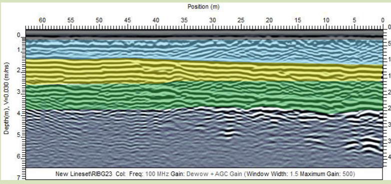

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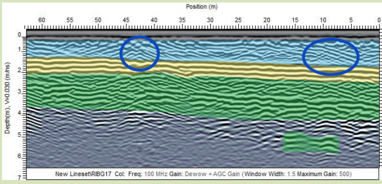

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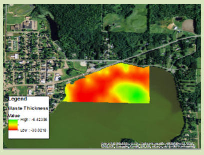
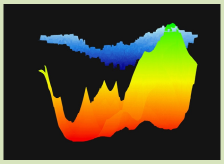
3D Model



Using probing data from 150 individual holes. Depth to sediment, depth to bottom and possible log locations were recorded along with exact latitude and longitude coordinates. The data was entered into an excel file and an equation was created to depict how thick the waste was. The excel file was imported into ESRI ArcMap and given a color scheme showing **RED** as deeper and **GREEN** as less thick waste. The file was then imported into ArcScene where the darker the blue the deeper the water level was. The second layer is representing the furthest contact point. The black in between the two layers is representing the waste thickness.



Conclusion and Future Work

In profile 1, the AGC Gain was able to capture more data then the SEC Gain. Although both profiles go about 2 meters in depth before reflections start appearing, the AGC Gain shows much more detail. In profile 2, once again the AGC Gain shows more detail then the SEC Gain. Unlike the SEC Gain, the AGC Gain for profile 2 does not show an unknown feature in the northern portion of the profile. Lastly profile 3, similar to profile 2, the AGC Gain does not pick up the unknown feature, yet both the SEC and AGC Gain go about 2 meters in depth before the reflections start occurring. Overall, the AGC gain is better for picking up finer details, but when dealing with reflections, both gains are about equal.

Future work will include going back into the field to collect additional datasets on the lake, using already captured data to produce additional maps, and find new log locations. This data will be presented to the Village of Rib Lake as a possible base layer of dredging plans.

ACKNOWLEDGEMENTS

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RESOURCES

Jol, H.M., and Albrecht A., 2004, Searching for submerged lumber with ground penetrating radar: Rib Lake, Wisconsin, USA, Tenth International Conference on Ground Penetrating Radar, p. 601-604.

Jol, H.M., and Bristow, C.S., 2003, GPR in sediments: advice on data collection basic processing and interpretation, a good practice guide in C.S. Bristow, H.M. Jol, eds., GPR in Sediments: Geological Society Special Publication 211, p. 1-7.

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