A Search for Industrial Waste and Buried Logs in Rib Lake

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University of Wisconsin-Eau Claire
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A Ground Penetrating Radar Test Using Ice as a Platform
Drake Bortolameolli, Sean Morrison, Dr. Harry Jol (UWEC Geography and Anthropology), Arlen Albrecht (UW Extension)

Abstract
The purpose of this collaborative research project is to use ground penetrating radar to detect the amount of organic industrial waste that has accumulated on the bottom of Rib Lake. Between the years of 1882 and 1948 industrial waste from the local timber mill was deposited into the lake. In addition, Rib Lake was used as a holding pond for logs. Occasionally, logs would break away from the cluster and sink to the bottom. Today the organic waste is responsible for deteriorating the health of the lake, due to the excess amount of algae blooming in the lake, absorbing much of the oxygen. Using Sensors & Software ground penetrating radar equipment; we shot multiple lines using 50 and 100 MHz antennae frequencies spanning over 200 meters in length. Earlier studies on the lake have been conducted by towing the equipment behind a boat in the open water. Our study involves towing the equipment across the frozen lake surface on a custom-made dual toboggan transport. We captured data containing information about the thickness of waste and location of sunken logs. After processing the data, we will create maps showing: water depth, thickness of waste, locations of submerged logs, and areas of high organic industrial waste deposits. This information will help aid in future planning of extracting logs, dredging and cleanup of the Rib Lake.

Introduction
Between 1870 and 1940 much of the northern Wisconsin forests were cut and the timber was used for many different usages: such as building infrastructures and wood furniture. Rib Lake, Wisconsin was an important center for the lumber industry. Using the 324-acre Rib Lake as a holding pond for a lumber mill, Rib Lake produced over 1.4 billion feet of timber. Since there were not any laws against dumping industrial organic waste into the lake, the lumber mill released their waste directly into Rib Lake. Everything from saw dust to animal hides was dumped into the lake over the 70 years of operation. As a result of years of dumping waste, into the lake, it is now in a eutrophic state, meaning there is a large amount of plants using oxygen, so it then kills off the animals living in the lake. The lake has accumulated between 3 and 10 meters of industrial waste (Jol and Albrecht, 2004). When the mill was open, logs in the holding pond would occasionally become waterlogged and sink to the bottom. Today, these logs are worth far more than any typical cut down tree, due to their age and rareness. Being able to locate these logs and extract those from the lake would bring in a large amount of money to the community. In turn the community would use the money from the logs to help offset the cost to clean and possibly dredge the lake. Several logs have been pulled from the lake already; one in particular is displayed outside of Camp 28, in Rib Lake, WI.
Background

The previously collected data of Rib Lake included; 140 GPS located probing locations, coordinate points, depth to sediment, depth to potential logs, and depth to bottom of lake. Using this data, we created two maps, using ArcMap as well as Microsoft Excel, one showing all the probing locations, and potential logs with their associated depths, and a sediment thickness map showing how thick the industrial organic waste is across the section of the lake. Using this data, we determined where we wanted to run GPR lines across the lake, based on where we believed the most sediment was.

Methods

The sled used for this project was a custom-built dual toboggan transport. The GPR antennae sat in between the two toboggans, all held together and pulled across the ice by rope. The GPR frame was constructed using PVC piping. In order to prevent snow from damaging the equipment, two smaller sleds were put between the toboggans for the equipment to rest on. Using Sensors & Software GPR equipment, we collected both 50 and 100 MHz antennae frequencies, for a total of five GPR lines each spanning over 200 meters across the ice. While the sled was being pulled across the ice, the GPR equipment was emitting pulses of electromagnetic waves, which reflect off changes in dielectric properties of sediments (Jol and Bristow, 2003). The time from pulse to return is measured and using the velocity of materials (0.03 m/ns) we can determine how deep the feature causing the reflection is.

Results

We successfully shot multiple GPR lines using the ice as a platform. Several hyperbolic diffractions found in GPR images are presumed to be submerged logs. Due to the years of dumping into the lake, we can see industrial organic waste surrounding the logs. The logs are buried within the sediment.

The logs, circled in red, are within the organic waste at various depths ranging between 2.5 and 5 meters beneath the surface. There is between 1.5 and 3 meters of organic waste, yellow line, piled on top of the logs, with an additional 1-2 meters of water and ice on top of that.

Both the 50 and 100 MHz antennae picked up multiples. These duplicated lines are seen because the ice is causing the electromagnetic pulses to reflect back downward. Another feature we see protruding from the surface of the lake and almost emerging from the industrial waste is a type of rock structure. This rock structure starts beneath the industrial waste and breaks through the layer of waste.

The rock structure has upwards to 5 meters of industrial waste on top of it, and as the rock emerges, the water becomes shallower, and eventually we do not see any more waste on top of the feature. In the sediment thickness map we can see that the rocks location is in an area of very low waste, and the GPR profile confirms that. We also can see the rock flattens out at 1 meter in depth below the ice, and eventually drops off to about 5 meters in depth below the surface.
Conclusion

Using the dual toboggan constructed sled to house the GPR antennae, we were able to use the ice as a platform to capture multiple lines of data expanding over 200 meters in length. Using the processed data we found several log locations, as well as thickness of the industrial organic waste and where the waste is located. Already Rib Lake has extracted a couple logs, but now with this data they can accurately locate where other logs are, and possible extract them.

Future Work

Future work will include

• Collecting additional data
• Capturing other areas of the lake using the ice as a platform
• Producing maps of industrial organic sediment deposits
• Producing maps of log locations with their presumed depths
• Presenting the data to the village
• Possible dredging of industrial organic waste
• Possible extraction of logs

Acknowledgements and References

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A GROUND PENETRATING RADAR TEST USING ICE AS A PLATFORM

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INTRODUCTION

Between 1870 and 1940 much of the northern Wisconsin forests were cut and the timber was used for many different usages: such as building infrastructures and wood furniture. Rib Lake, Wisconsin was an important center for the lumber industry (Figure 1 & 2). Using the 324-acre Rib Lake as a holding pond for a lumber mill, Rib Lake produced over 1.4 billion feet of timber. Since there were no laws against dumping industrial organic waste into the lake, the lumber mill released their waste directly into Rib Lake. Everything from saw dust to animal hides was dumped into the lake over the 70 years of operation. As a result of years of dumping waste, the lake has accumulated between 3 and 10 meters of industrial waste. Due to the years of dumping waste, we can see industrial organic waste surrounding the logs. The logs are buried within the sediment (Figures 9 & 10).

The lake has accumulated near 1.5 and 3 meters of organic waste, yellow line, piled on top of the logs, with an additional 1-2 meters of water and ice on top of that (Figures 9 & 10).

CONCLUSION

Using the dual toboggan constructed sled to house the GPR antennae, we were able to use the ice as a platform to capture multiple lines of data expanding over 200 meters in length. Using the processed data we found several log locations, as well as thickness of the industrial organic waste and where the waste is located. Already Rib Lake has extracted a couple logs, but now with this data they can accurately locate where other logs are, and possible extract them.

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