Hydro-Vulnerability Assessment

Chevak, Alaska

September 2021

Photo: A beautiful day in Chevak, Alaska in September 2021. Picture taken with a UAS (drone).

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ONE PEOPLE-ONE RIVER

Yukon River Inter-Tribal Watershed Council

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Executive Summary: The YRITWC worked with the Chevak Traditional Council and the City of Chevak to assess threats related to water, or hydro-vulnerabilities in their community. This is not a comprehensive document, but includes what we can learn from using an Unmanned Aerial System (UAS or drone) in addition to some easily available tools.

An issue was identified in the drainage of the sewage lagoon, which could potentially be a pollutant transport pathway to drinking water resources. Erosion was documented that can be used as a baseline for future monitoring, or compared with historic imagery to track past erosion, and a potentially contaminated site was added to the YRITWC's Brownfields inventory.

Introduction: A hydro-vulnerability assessment is a look at how water moves around a community, and how that movement may impact human health and well-being. Permafrost melt and increased rainfall, resulting from a changing climate, is destabilizing once frozen landscapes leading to increases in erosion and changes in contaminant pathways. This assessment includes 1.) an examination of the landfill, and sewage lagoon using a UAS and publicly available tools. 2.) documentation of river and other erosion 3.) documentation of a Brownfields site to target for clean-up.

For this work an UAS (or drone) was used equipped with infrared and NDVI sensors. DroneDeploy software was used to mosaic images together and create elevation and NDVI maps. Additional tools that were used included GoogleEarth historical imagery, and the Alaska Department of Environmental Conservation (AK DEC) datasets (community drinking water intakes, drinking water protection areas and contaminated sites).

LANDFILL and SEWAGE LAGOON

Figure 1 includes the area flow with a UAS, and community drinking water sources and drinking water protection zones from AK DEC. Community drinking water is classified as 'Groundwater – System has a groundwater source that is not under the direct influence of surface water (e.g., protected wells) and no surface water or groundwater under the influence of surface water sources.' Drinking water protection zones are also shown. The red line shows 'several month time of travel' meaning it would take waters in this zone several months to reach the community intake of groundwater. The orange line shows '2 year time of travel', so surface waters in this zone would take 2 years to reach the water intake.

A concern was identified by tribal leadership about the drainage of the lagoon reaching the community, or community drinking water. Figure 2 shows that if the lagoon is draining toward the community, or the drinking water source, it could be a potential hazard to human health. In order to investigate this concern we first looked at the elevation map from the UAS imagery, and overlaid it with a lower resolution digital elevation model found in ArcGIS's Living Atlas (see figure 3). It confirmed that there are two low spots that could be potential drainages.

The lagoon was also mapped using a UAS equipped with a multispectral double 4K sensor that took images to calculate the Normalized Difference Vegetation Index (NDVI), a measure of plant health. Healthy plants emit a certain combination of light, and near infrared (see Figure 4).

In figure 5 red indicates unhealthy or dead vegetation (red is dead) while darker green denotes photosynthetic activity and healthy vibrant plants. Plants need nitrogen, phosphorus and potassium to grow. Sewage lagoons are rich in nitrogen and phosphorus (similar to fertilizers). So more sewage will cause plants to be greener. The two map panels on the right are a close up of the area of concern. There

are four main ‘fingers’ where plants are very healthy. In addition, from the aerial imagery and from on-the-ground investigations, we can see these areas are wet. This provides more evidence that the lagoon is leaking out of the eastern side.

Figure 6 is a closer look at the input pipe. By looking at the color of the water we can have an idea where the input is draining toward initially. The turbid (or brown) water from the pipe, the input, is initially flowing to the southeast toward the area of concern for drainage. Some is flowing north, but it doesn’t look like that flow is draining. The initial sewage input flowing toward the four fingers to the southwest is a concern, because if sewage is leaking before it has spent time processing in the lagoon it could be more hazardous.

The drinking water source for Chevak is groundwater that is not under the direct influence of surface water. There are two drinking water wells at 165 ft. or deeper. Permafrost is about 137 ft. deep, and acts as a barrier between surface water and groundwater, and overall susceptibility to contamination is low. If harmful sewage reached the drinking water protection zone marked on the maps in red, it would still take several months to reach the source of drinking water, if everything is working properly. In 2021 e. coli was found in the community drinking water in February, and again in July. Since records began on the wells in 1995, there have been 13 violations of either e.coli or coliform, although it is difficult to determine the source.

Based on these maps it does seem likely that the lagoon is at least partially draining to the east toward a natural lagoon that is surrounded by residential houses. It is difficult to know the extent of the drainage, and potential hazards without additional studies, but this is a potential hazard, especially during flooding events. Further investigation, and examination by an expert is warranted.

Figure 1. Overview of landfill, community drinking water source and drinking water protection zone.

Figure 2. The concern is that the lagoon is draining following the red arrow, instead of away from the community as shown with the green arrow.

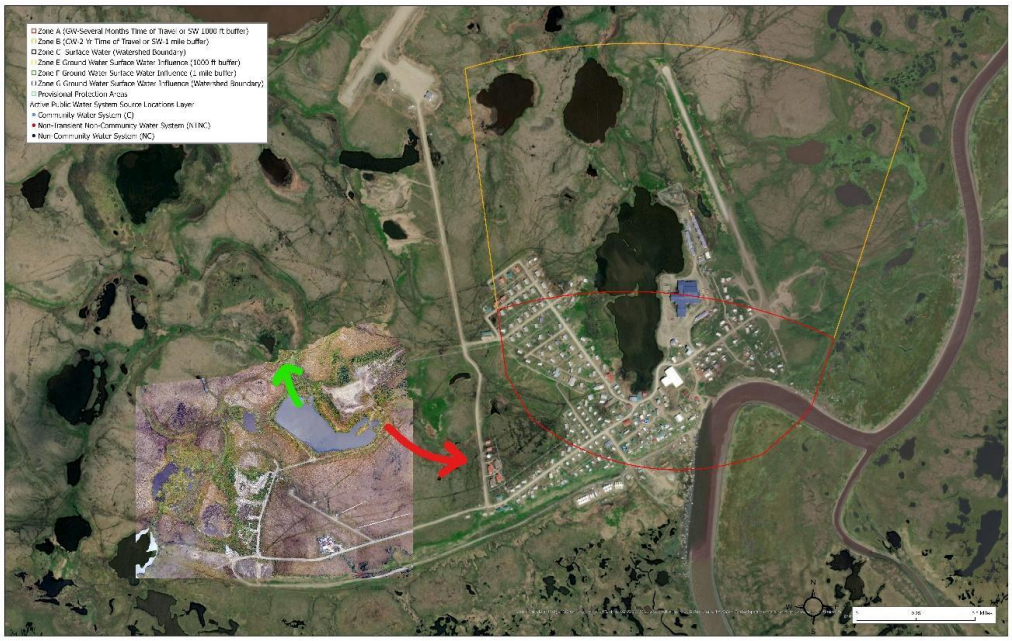


Figure 3. Elevation map.

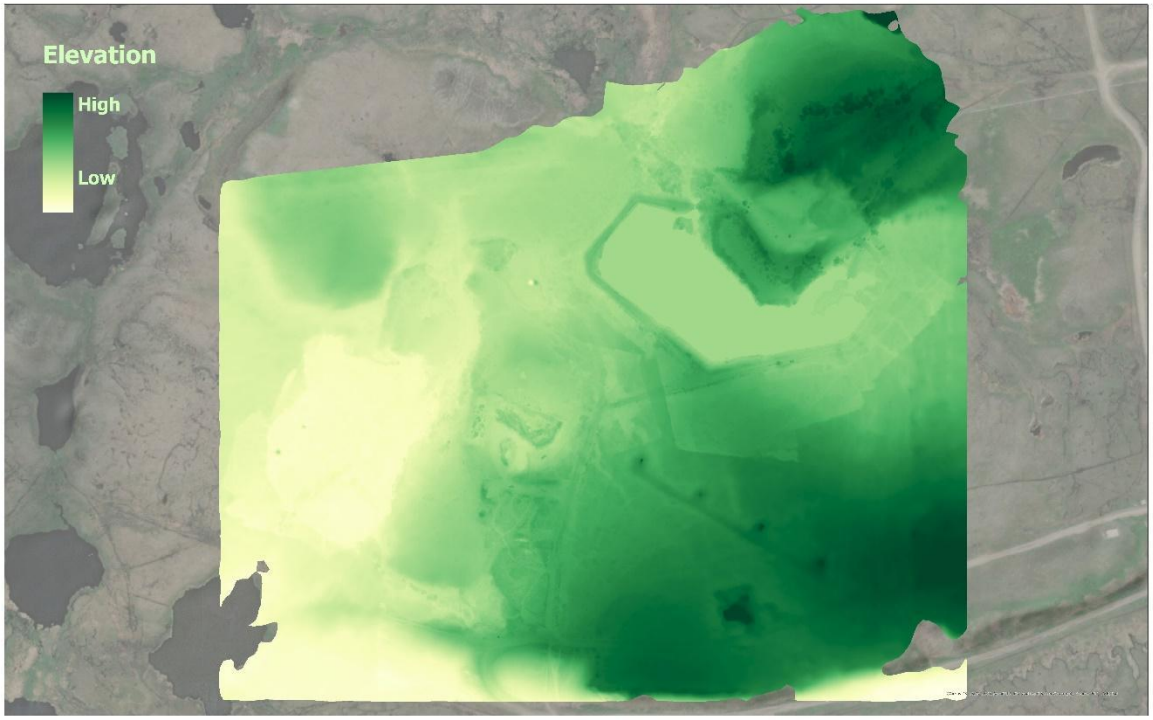


Figure 4. How NDVI is detected.

Figure 5. Vegetation stress map.

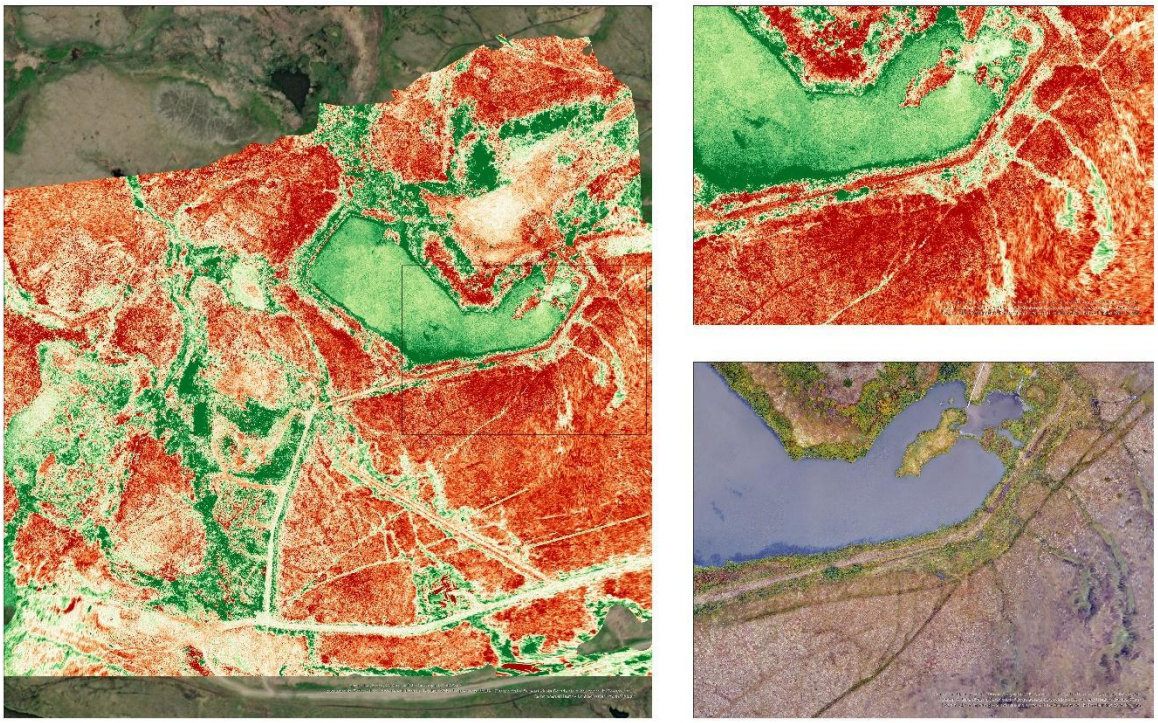
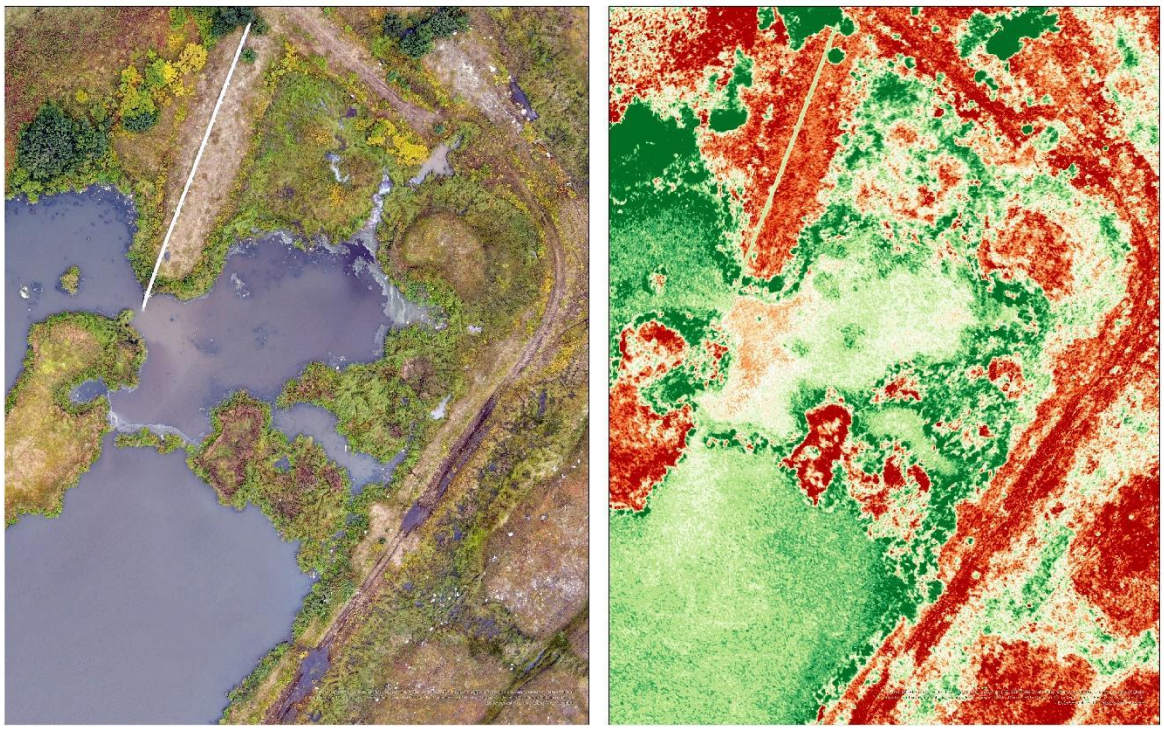


Figure 6. A close up of input pipe.



EROSION

The section of the river flown and mapped using the drone was compared to historic images from 2007, 2008, and 2019 from Google Earth satellite imagery (see Figure 7). A red box marks the area that has eroded during this 14 year period. McKinley St. eroded into the river from 2008 to 2019. It is clear that river erosion has impacted Chevak, and will likely continue to be a concern, given the important community infrastructure located near the area that has experienced the most rapid erosion.

Similar to the vegetation stress maps, thermal imagery is created by a sensor that is able to 'see' beyond what we do. It collects small differences in the amount of heat an object is emitting. Figure 8 shows how a thermal image documents differences in heat. As you would expect, humans in the image are warmer than the surrounding, and exposed skin, like faces and hands are the warmest areas.

Figures 9 and 10 document an area of concern for erosion. The erosion is happening very near a residential area and threatening homes. Figure 9 documents the erosion and future images can be compared to this one to track the erosion.

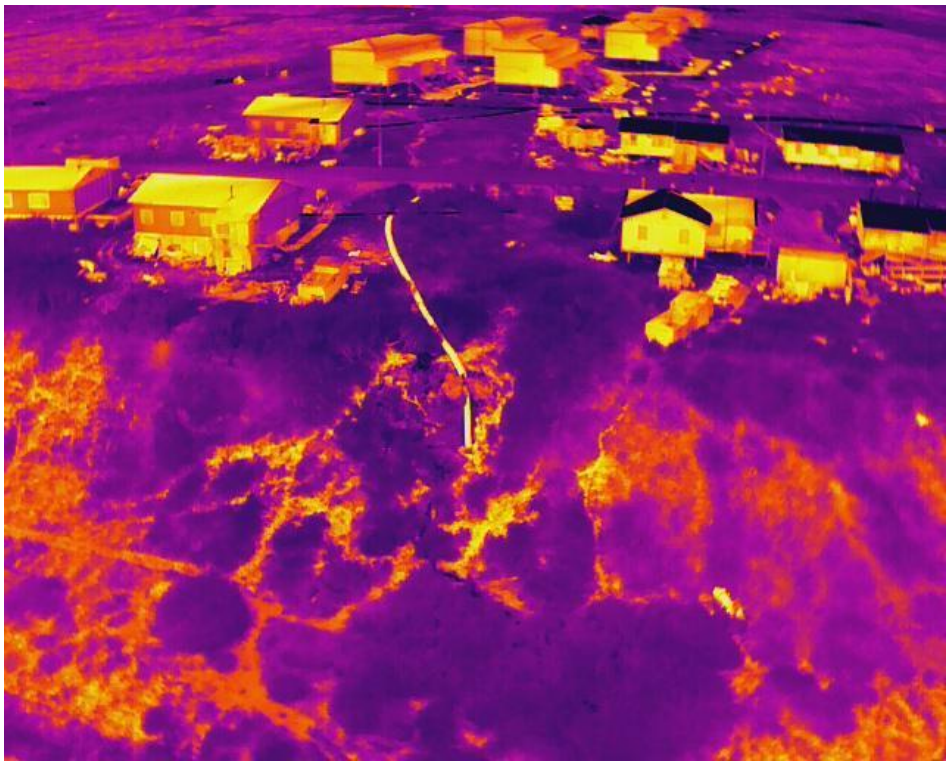
The thermal image (figure 10) was taken on September 1, 2021 at 3:40pm on an overcast day. The sun has warmed the surface. From the thermal imagery you can see how much warmer the black pipe is than the white ones. The warm black pipe could be contributing to melting the ground, although there are likely additional forces of flowing water at work. To try and slow erosion here the black pipe could be wrapped in tin foil or something reflective.

Figure 7. Historic aerial satellite imagery compared to the riverbank mapped in 2021 using the UAS.

Figure 8. A thermal image where hotter areas are red, and cooler areas are blue besides a red, green and blue image (what we see).

Figure 9. Area of concern for erosion near residential areas

Figure 10. The same image as figure 9 as a thermal image.



BROWNFIELDS (or potentially contaminated sites)

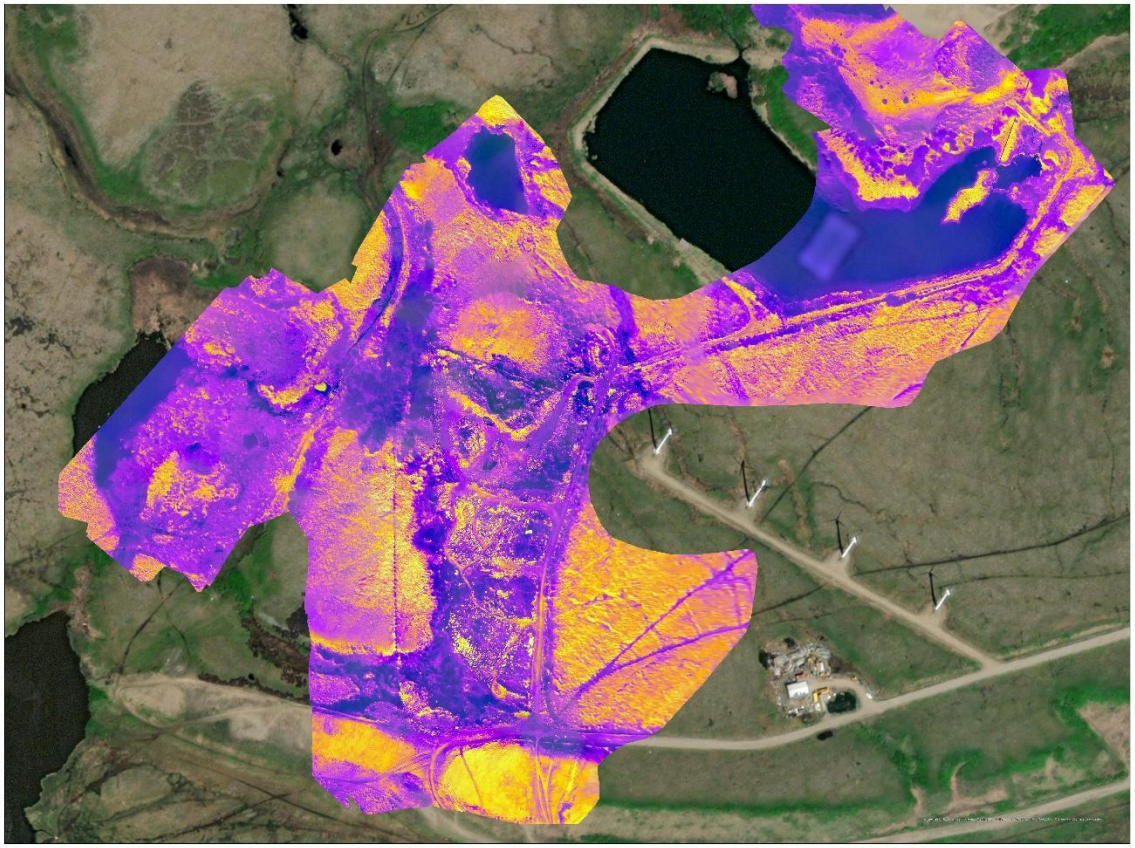
A Brownfield, or potentially contaminated site, was identified by the Tribal Environmental Professionals in Chevak. This site is an illegal dumpsite that was buried until recently, when the river began eroding it away. Figure 11 served as documentation for the addition of this site into our YRITWC Brownfields inventory. This is a first step toward working to have the site assessed and cleaned-up. Clean-up is important so that the contamination doesn't reach the river, or impact human health and safety.

Figure 11. A potentially contaminated site located near where the river is most rapidly eroding.

OTHER

The image in figure 11 was taken on September 1, 2021, at about 2:30pm on a cool, overcast day. The sun's warmth has had some time to warm dry areas. There is an interesting square shape in the lagoon that is causing the water to be a little warmer.

Figure 11. Thermal image of landfill, where blue is cool and yellow is warm.



Conclusion: This report includes an aerial photo assessment of the landfill and the sewage lagoon, two areas of concern for erosion and historic satellite imagery, and documentation of a contaminated site that was added to YRITWC's Brownfields inventory. As climate change contributes to permafrost melt, contaminants may become more mobile, and erosion may accelerate. Permafrost and water quality are being monitored by Chevak Traditional Council's Environmental Department in partnership with YRITWC's Indigenous Observation Network. This report represents a snapshot in time and it is our hope that it may contribute to future monitoring and assessment toward achieving community goals and priorities.