

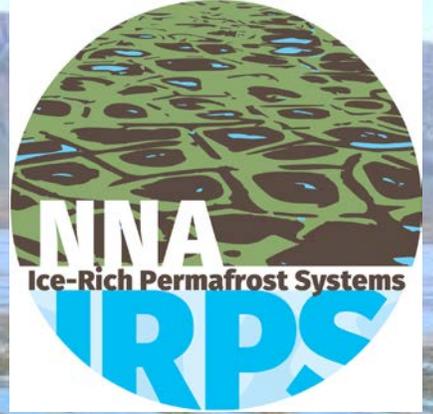
Understanding infrastructure risk due to permafrost thaw to inform decision-making in Point Lay, Alaska



Presentation to the NNA Community Office Meeting | November 15, 2022

Session: Interactions between the Built and Natural Environments

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Navigating the New Arctic:
Landscape evolution and adapting to change
in ice-rich permafrost systems

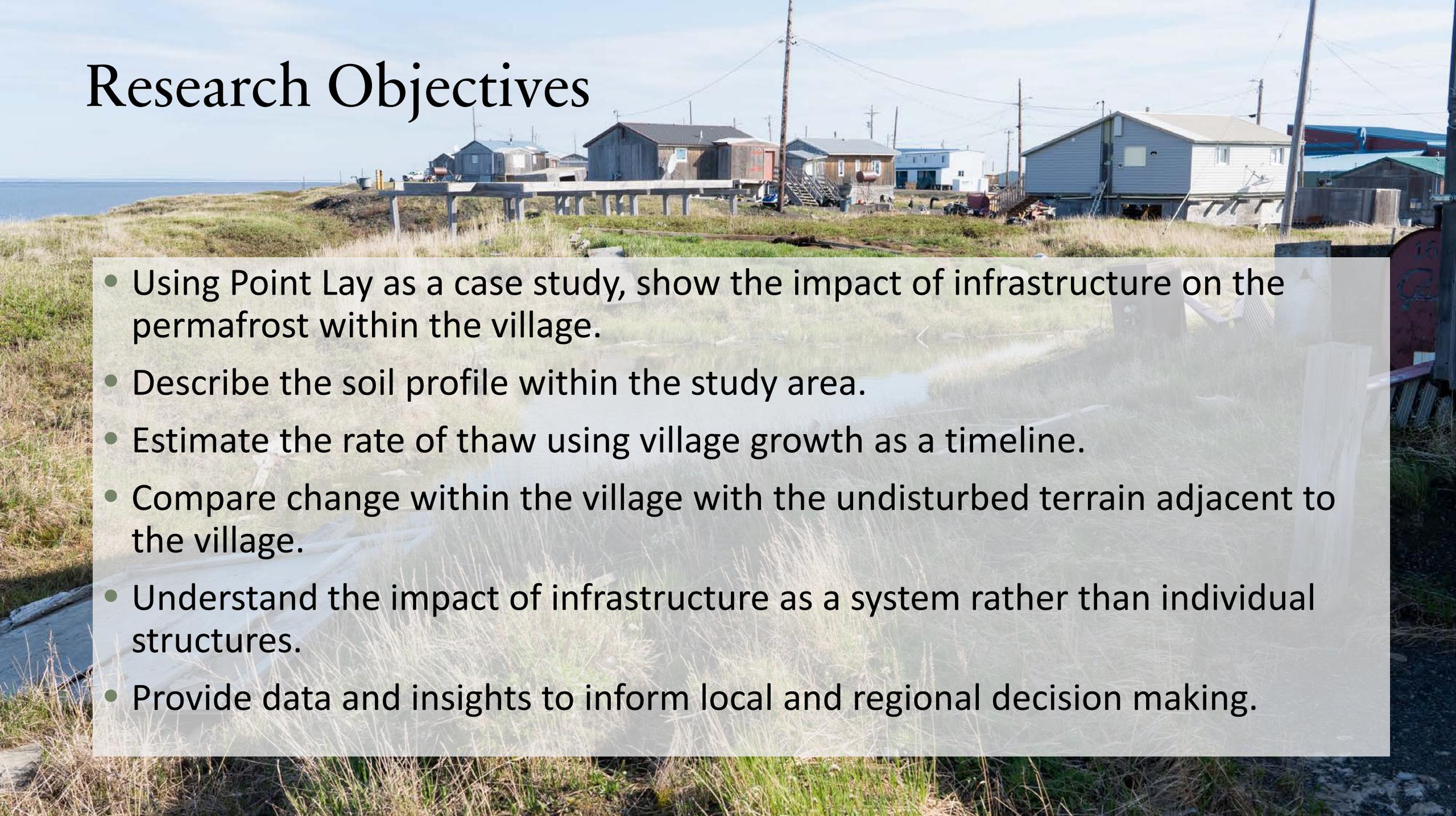
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- Navigating the New Arctic - Landscape Evolution and Adapting to Change in Ice-Rich Permafrost Systems
- Arctic Natural Sciences - The Transition Zone of Upper Permafrost: The Frontline for Permafrost Changes across Climate and Landscape Gradients
- Arctic Systems Sciences - Causes and Consequences of Catastrophic Thermokarst Lake Drainage in an Evolving Arctic System.

Research Objectives

The background image shows a coastal village with several houses built on stilts. The houses are mostly light-colored with dark roofs. In the foreground, there is a grassy area with some utility poles and wires. The ocean is visible in the distance under a clear sky.

- Using Point Lay as a case study, show the impact of infrastructure on the permafrost within the village.
- Describe the soil profile within the study area.
- Estimate the rate of thaw using village growth as a timeline.
- Compare change within the village with the undisturbed terrain adjacent to the village.
- Understand the impact of infrastructure as a system rather than individual structures.
- Provide data and insights to inform local and regional decision making.



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June 2022 Field Research

Alaska Communities Vulnerable to Permafrost Related Hazards

Alaska Vulnerability Assessment
Sponsored by the Denali Commission

Thawing Permafrost Rankings

Table A-13. Permafrost Group 1 (by ranking from highest to lowest). Communities with the same ranking indicates equal threat ratings.

(1) Newtok	(4) Selawik	(4) Atqasuk	(6) Alatna
(2) Barrow	(4) Nunapitchuk	(5) Huslia	(7) Chefornak
(2) Point Lay	(4) Nightmute	(5) Chevak	(7) Mekoryuk
(3) Tuntutuliak	(4) Kwinhagak	(5) Eek	(7) Brevig Mission
(3) Kongiganak	(4) Nuiqsut	(5) Nunakauyarmiut	(8) Circle
(4) Saint Michael	(4) Buckland	(5) Stebbins	(8) Atmautluak
(4) Savoonga	(4) Sheldon's Point	(5) Kiana	(9) Nome Eskimo
(4) Noatak	(4) Wainwright	(5) Shungnak	(9) Kotzebue
(4) Kaktovik	(4) Noorvik	(6) Deering	

Table A-14. Permafrost Group 1 (alphabetical with ranking indicated).

Observations of landscape change

“Everyone has noticed the ground is falling. When I first moved to Point Lay the ground was flat. Now... there are real deep holes all over.” – Pearl Neakok, resident

“The house I’m in now – and most of the houses here – are on pilings. With the ground shifting and changing, it’s dropped quite a bit.... The pilings are showing more and more, and I can feel my house shake a little bit when my kids are running around.”

– James Henry, Tribal Council President



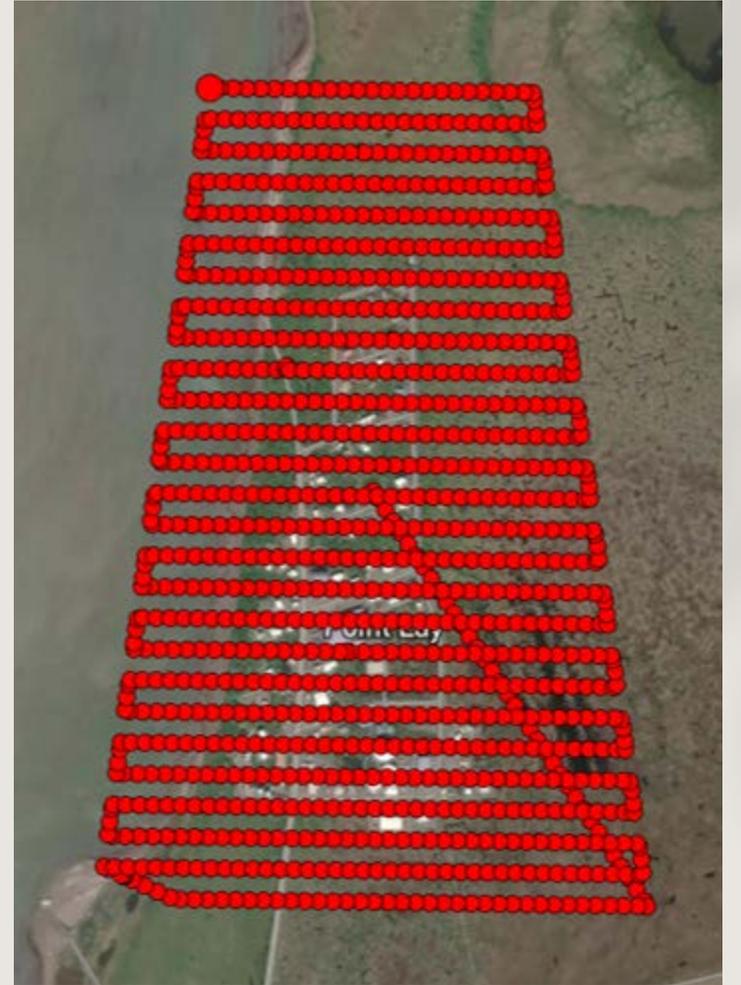
Subsiding ground:

In late 1980s, the base of the steps was at ground level and there was no thermokarst.
(CCHRC photo)

Infrastructure Rapidly Failing

- Water system failed and is being abandoned. Replacement cost estimated to be between \$140 and \$160 million to service 70 homes.
- One of three water tanks failed during the winter.
- Water supply lake lost due to river cutting through ice wedge.
- Homes being abandoned due to thawing permafrost.





UAV survey of townsite

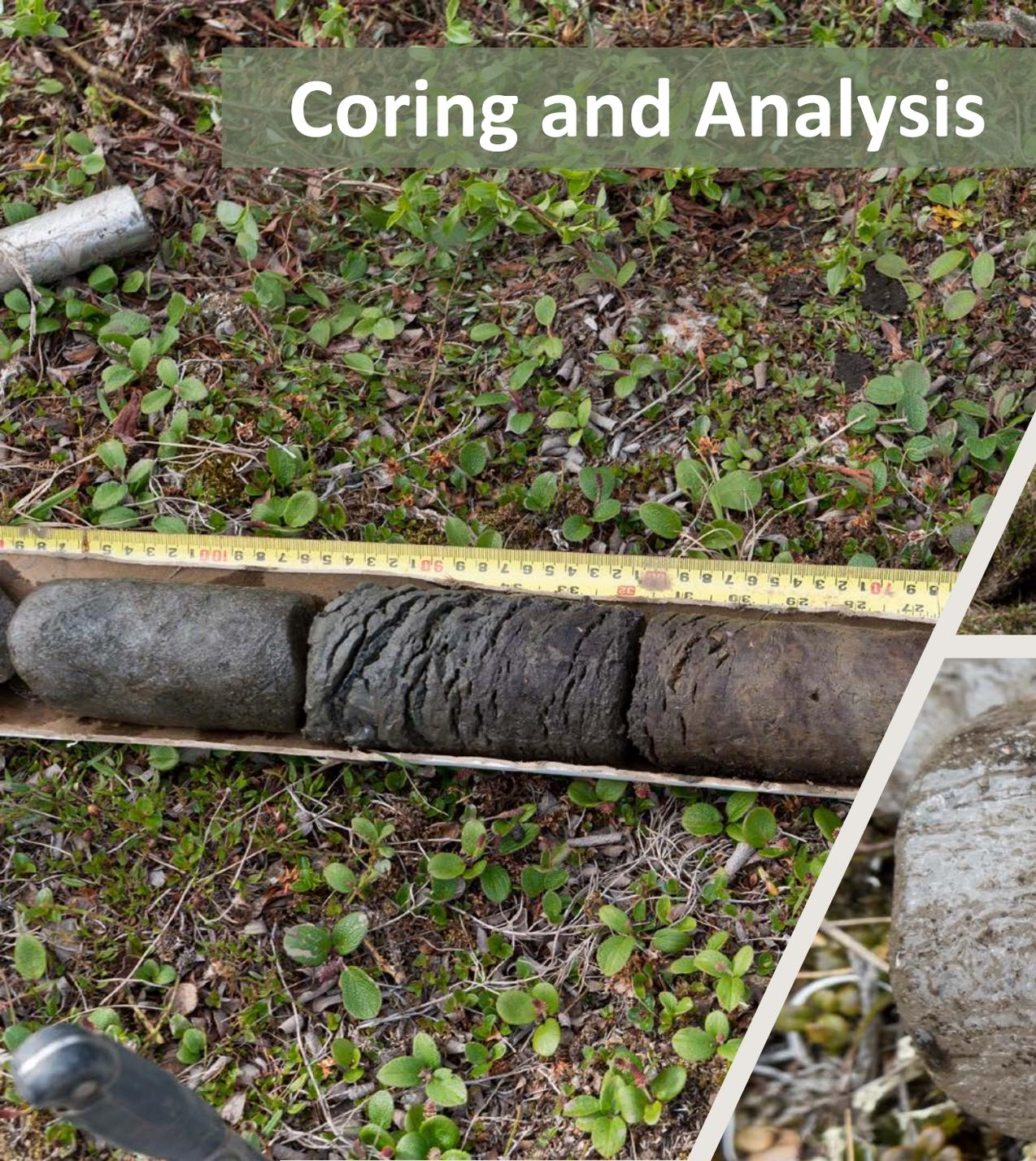
Data tied down to WGS84 UTM Zone 3N Ellipsoid Heights



Augering ice wedges to determine their depth



Coring and Analysis



Community Interviews

Perceptions of landscape change, impacts on daily life, concerns, best practices for engagement (with Tracie Curry, Northern Social-Environmental Research)

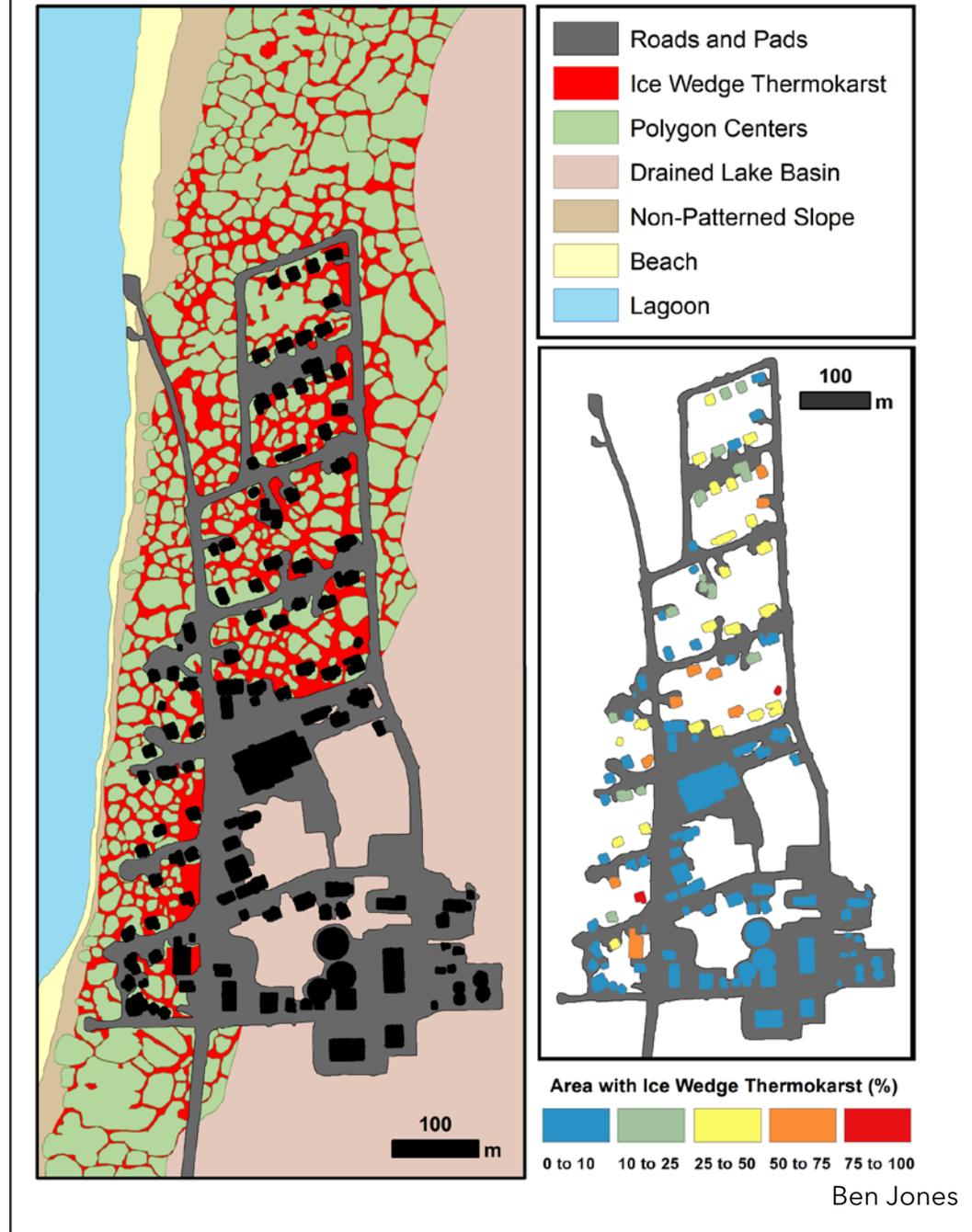
- Elder & lifelong resident
- Fire chief, S&R
- Mayor's Office liaison
- Young adult leader, village store clerk
- Local expert, elder
- Former Tribal president, lifelong resident
- Power Plant Operator, hunter

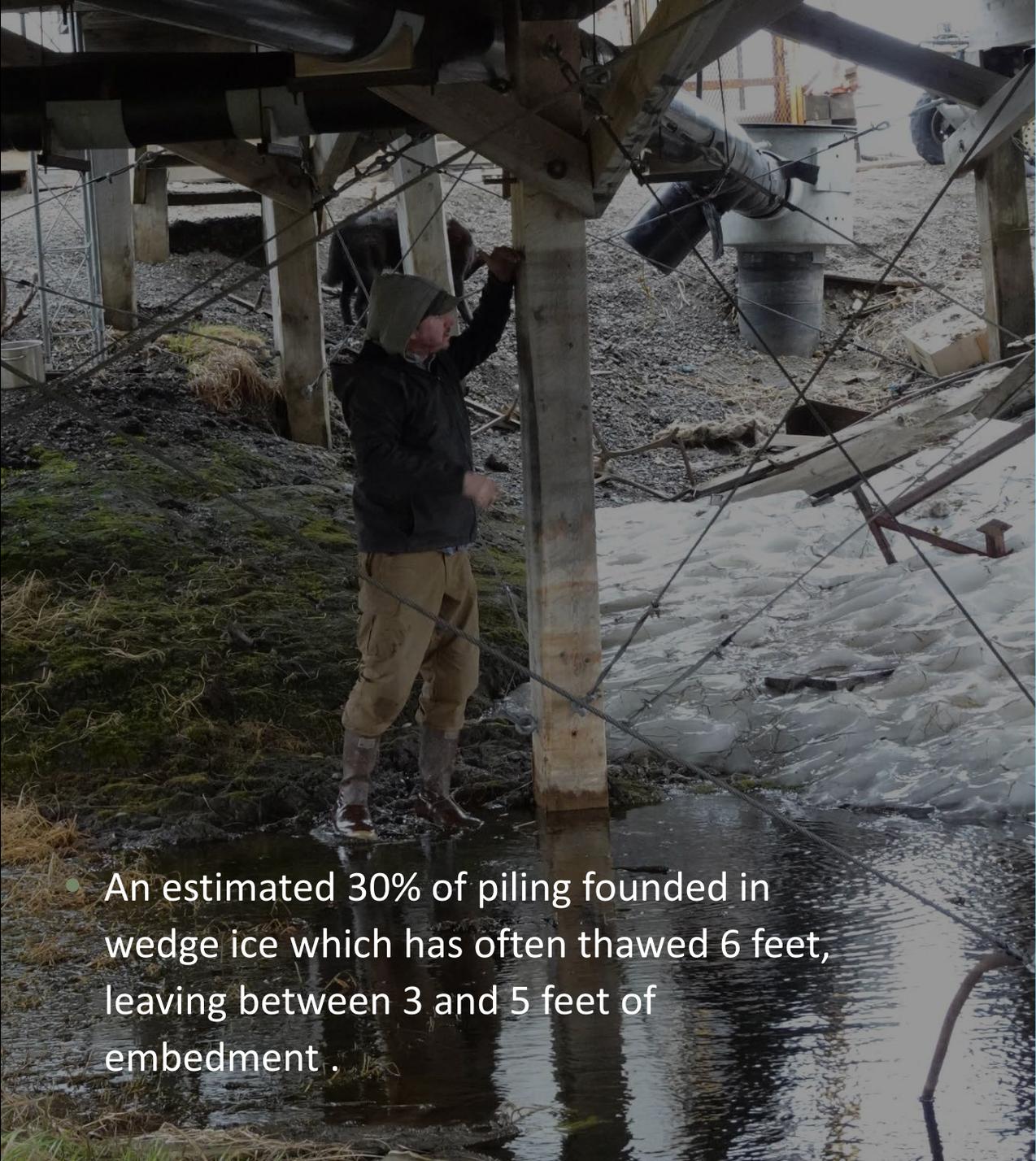


A wide-angle photograph of a coastal village. The foreground is dominated by a field of tall, dry grasses and green shrubs. In the middle ground, several small, simple houses are built on a slight rise. One prominent house is dark wood with white window frames. To its right, a green house is partially visible, along with a red shipping container. Several small boats are parked on trailers in the village. The background shows a clear blue sky with some light clouds and a distant horizon line.

What We've Learned

- The community is underlain by yedoma to the north and east and by a drained lake basin to the south and east.
- The terrain to the north is similar, but a little flatter.
- Ice wedges go to sea level and below (about 12 meters).
- Much less ice in drained lake basin, but wedge ice found.
- Landscape changes due to permafrost thaw are creating risks to life, health and safety: destabilizing buildings, exposing buried waste, endangering children due to deep ponding, and requiring new and longer routes to reach traditional hunting areas.





- An estimated 30% of piling founded in wedge ice which has often thawed 6 feet, leaving between 3 and 5 feet of embedment .

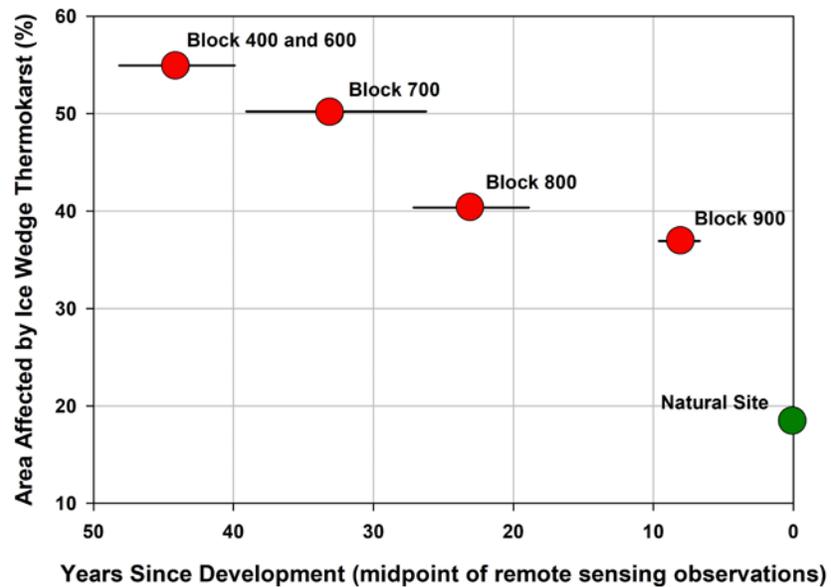
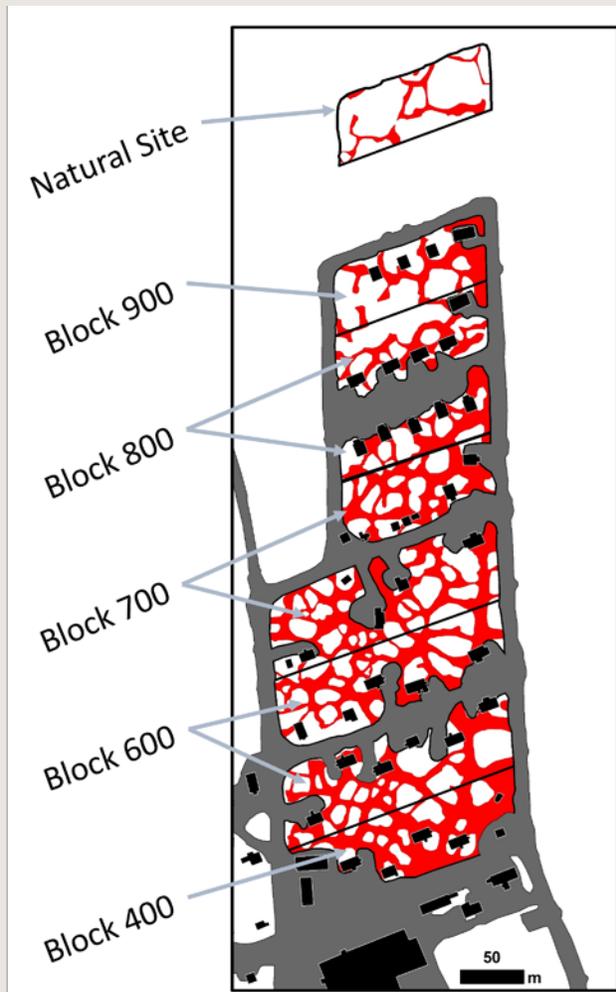




Some are entirely founded on ice.



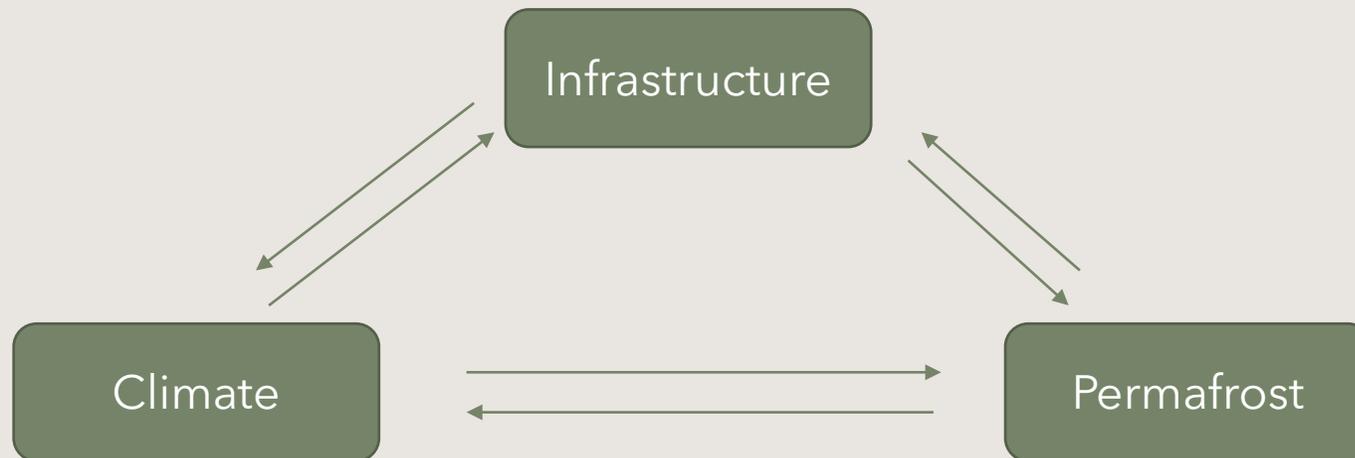
Thawing due to climate or infrastructure?



As the age of disturbance increases, the area of thermokarsts increases, and condition of the structures deteriorates. Note the undisturbed areas where the 1000 blocks are proposed has much lower thermokarst area even though the terrain is similar indicating that the infrastructure is the major stressor.

Impacts of Climate and Infrastructure

- It is really a system
- Engineers can only control the impacts of the infrastructure but must account for climate.
- Permafrost doesn't really care where the heat comes from.





Conclusions

- The permafrost thawing in the village is driven primarily by the infrastructure.
 - Increased snow drifting and snow storage
 - Increased ponding
 - Increased heat input direct and indirect
 - Altering of insulation provided by vegetation
- We must begin to consider the cumulative impacts of infrastructure in community planning.
- While infrastructure is the major driver, we cannot ignore climate change in our decision process.

Recommendations

- There are engineering solutions that must begin soon.
- Fill with fine grain soil to protect against further degradation.
- Build new construction on a soil pad after removing the upper portion of the ice wedges.
- Piling embedment should be at least 25 ft. More when founded in ice wedges. Use simple drilling by trained personnel to determine the location and depth of wedges.
- When possible, found piling in mounds.
- Implement an active maintenance program.



Sharing Back

- **Community Open House and Barbecue in Point Lay**
- **Meetings in Utqiagvik:**
 - **Point Lay Planning**
 - NSB Planning
 - Mayor's Office
 - **Water/Sewer Adaptation**
 - Umiag Design
 - NSB Public Works
 - NSB Capital Improvement Project Management (CIPM)
 - **Housing Adaptation**
 - TNHA Regional Housing Authority
 - Inupiat Communities of the Arctic Slope
 - TRIBN Lars Nelson
- **Presentation at design charrette for new water-sewer system**
- **Ongoing**
 - Local Steering Committee
 - Regional Advisory Group Meetings





Questions?