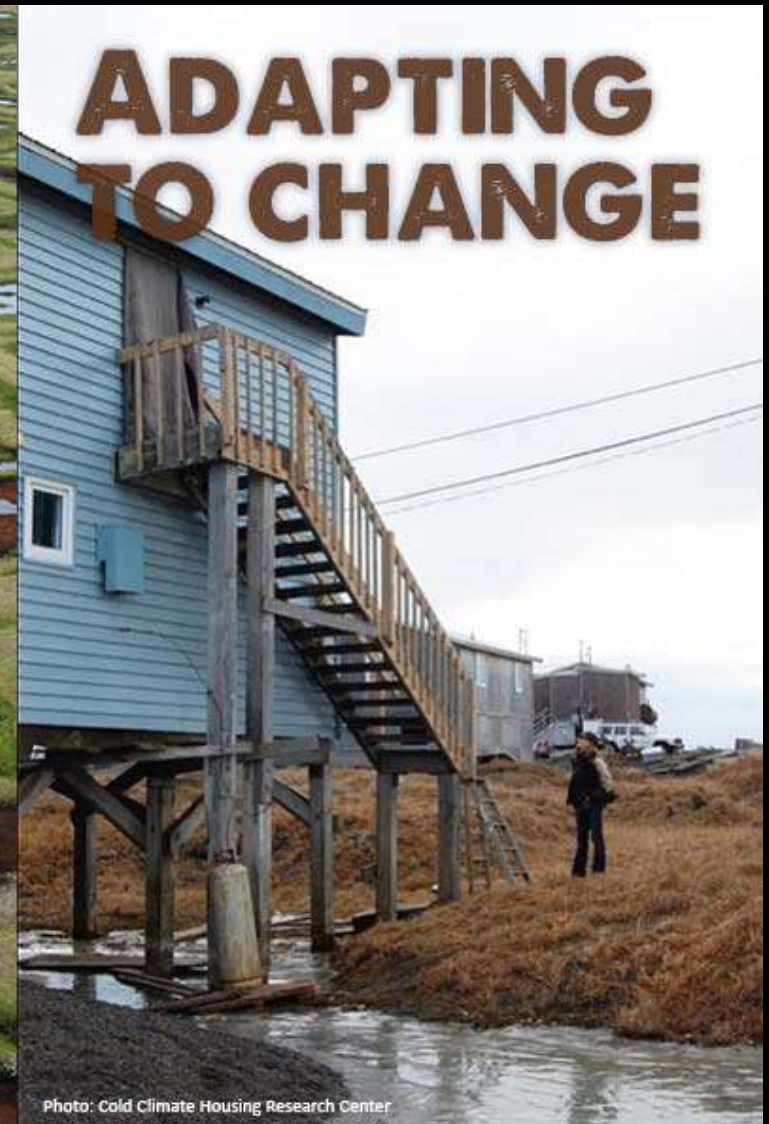
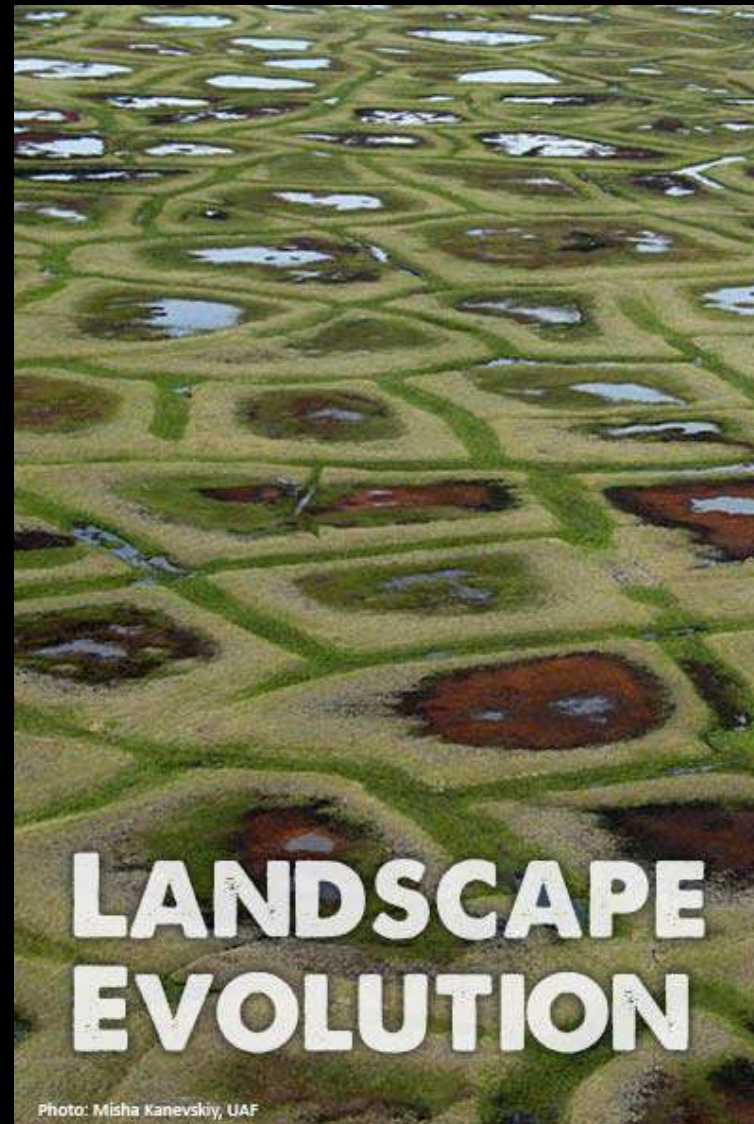


Navigating the New Arctic with a focus on ground ice

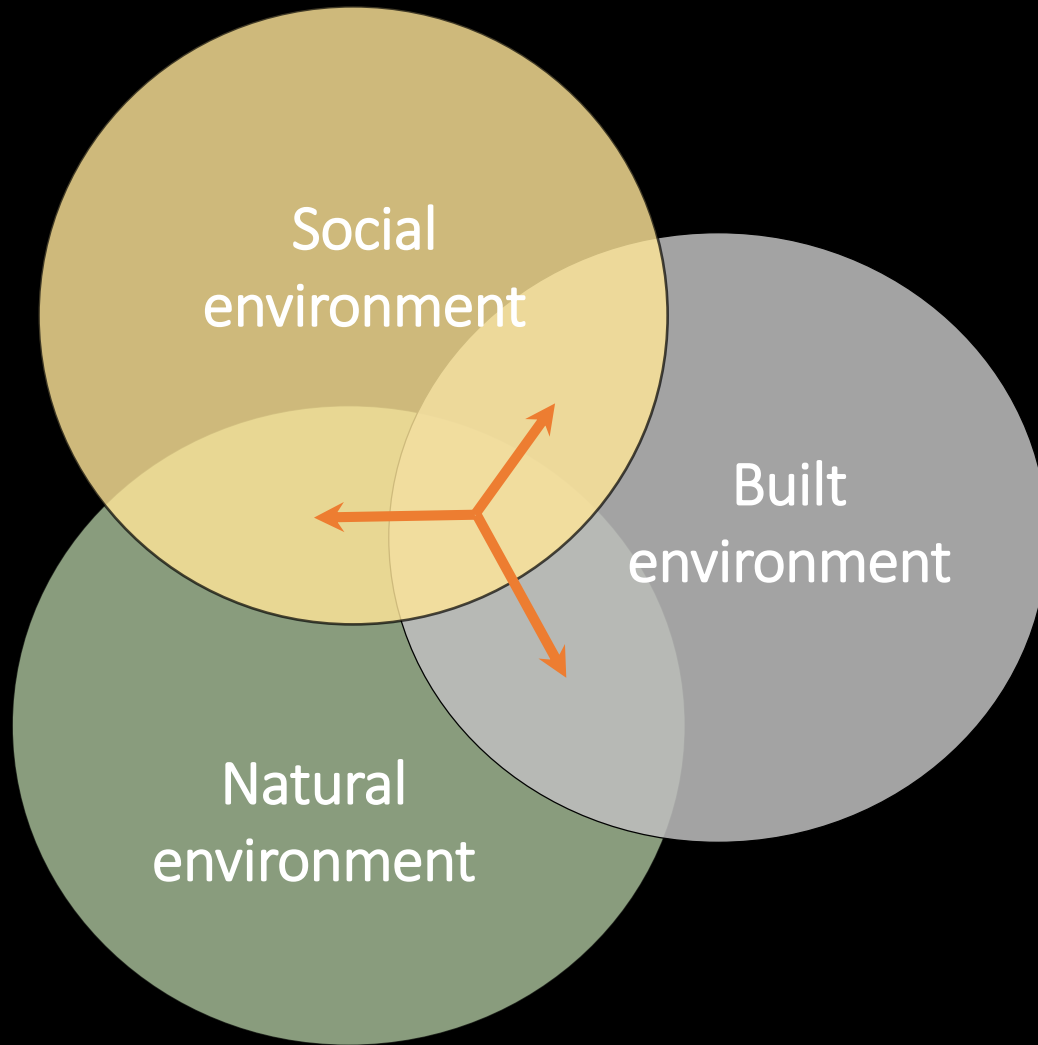
Landscape evolution and
adapting to change
in ice-rich permafrost systems
(NNA-IRPS)

D. A. “Skip” Walker and Jana Peirce
Institute of Arctic Biology, University
of Alaska Fairbanks (UAF)

RATIC/T-MOSAiC meeting at ASSW 2021, 21 March,
15:30-18:30 GMT



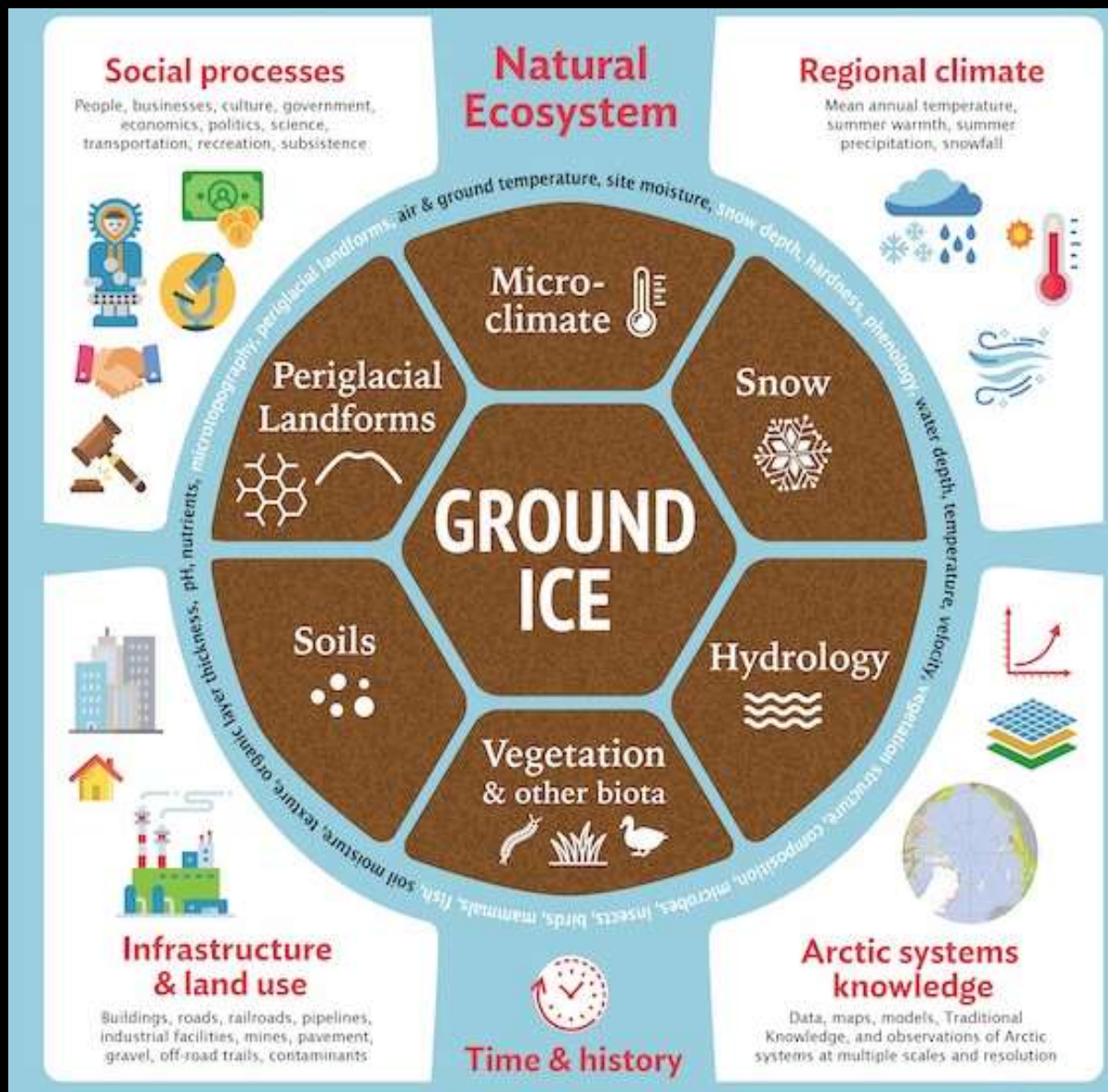
Overview



- Some background: Ice-rich permafrost systems (IRPS)
- Some successes (best practices)
- ❖ Coordination, Collaboration, and Co-development (Jana)

Navigating the New Arctic (NNA) framework

Ice-rich permafrost system



Overarching theme Ground Ice

- Literally, the glue that holds the system together
- Any reduction or major modification of ground ice affects the whole system



Ice wedge, Misha Kanevskiy



Coastal erosion of Ice wedges, USGS

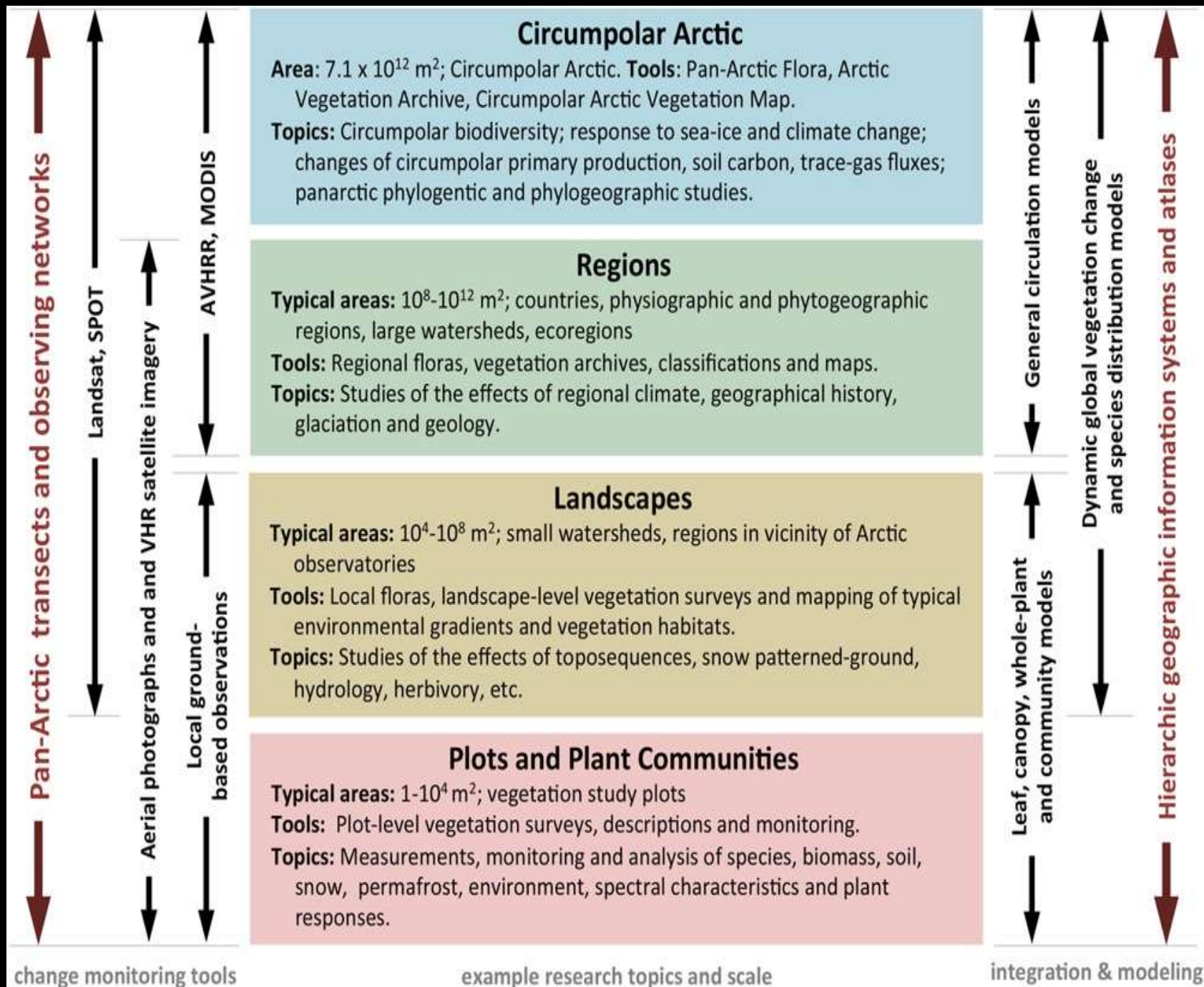


Low-centered and high-centered ice-wedge polygon, Misha Kanevskiy



Primary questions

- Where, why, and how is ground ice accumulated in IRPS?
- How do IRPSs evolve and how are they currently changing?
- How can people and their infrastructure adapt to IRPS changes?



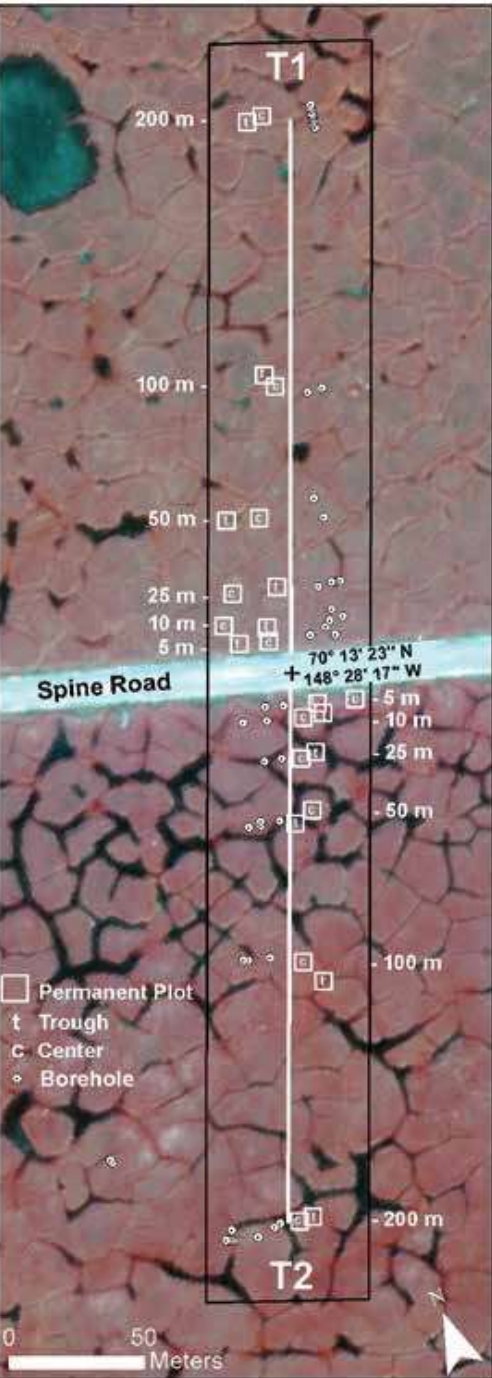
Hierarchical approach to study IRPSs

Walker, D. A., et al. 2016. *Environmental Research Letters*, 11(5), 1–16. <http://doi.org/10.1088/1748-9326/11/5/055005>

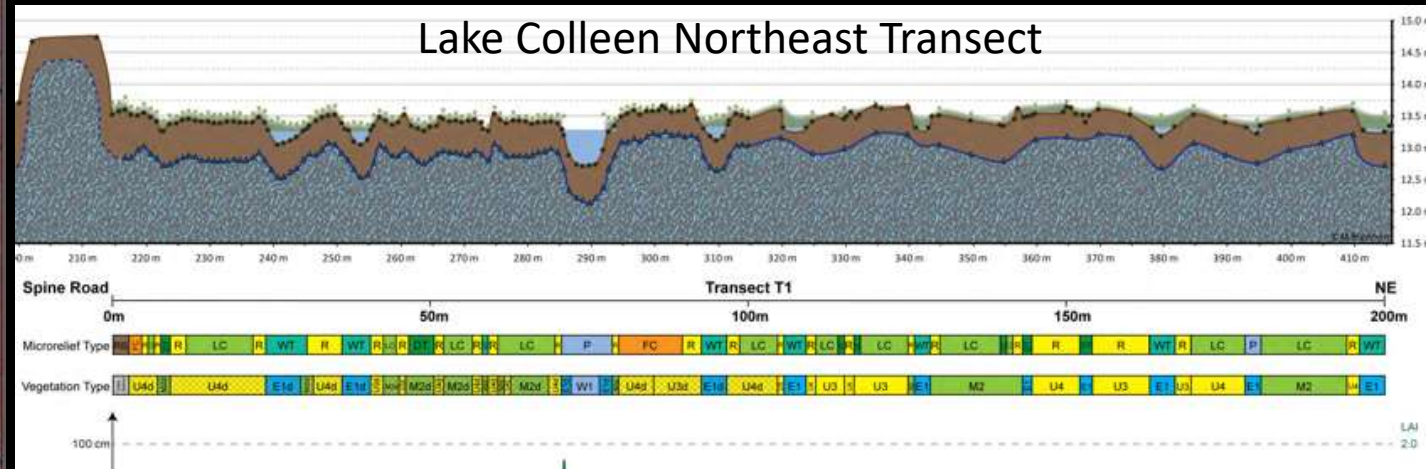
IRPS observatories

Plot-level observations and monitoring:

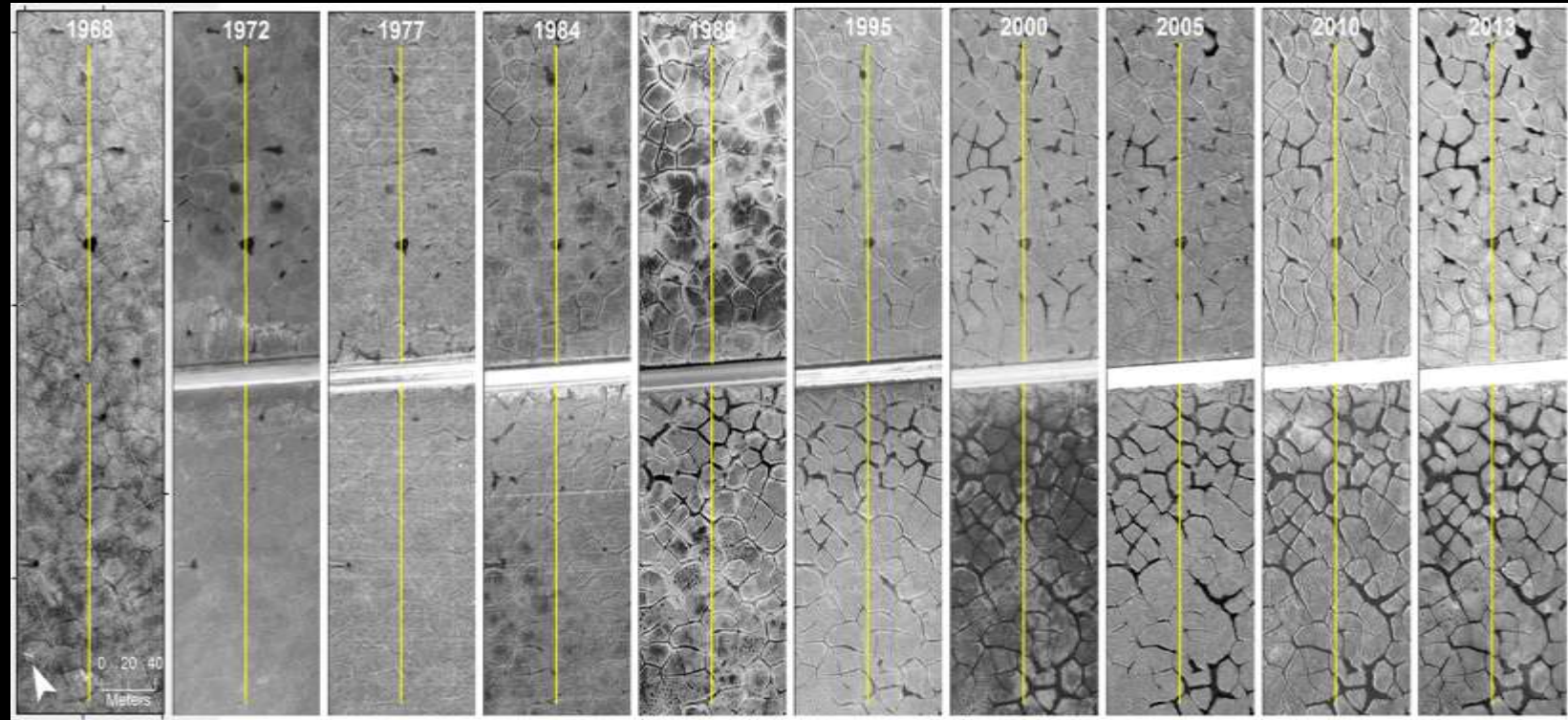
- Aerial photo time series
- Climate stations
- Permafrost boreholes
- Plot and transect surveys and mapping
 - Micro-topography
 - Active layer
 - Vegetation
 - Soil
 - Snow
 - Dust
 - Flooding



Lake Colleen Northeast Transect



Thermokarst ponds: Linkages to T-MOSAiC Freshwater theme



1. Thermokarst pond plot-level studies: Emily Watson-Cook, Misha Kanevskiy, et al.
 2. Remote sensing mapping and time series analyses: Ben Jones et al.
 3. Strong hydrology and modeling component: Anna Liljedahl, et al.
- Permafrost Discovery Gateway



Shur et al. 2016. *EICOP*.

Figure 1 consists of six cross-sectional diagrams (A-F) illustrating the seasonal evolution of a coastal plain. The diagrams show the progression of water flow, ice formation, and vegetation growth over time. A legend at the bottom identifies the various features and materials shown in the diagrams.

Legend:

- Snow
- Water
- Unfrozen soil
- S&L sand
- Ice wedge
- Polygon centers
- Slump
- Troughs filled with reworked silt and sand
- Underground erosion
- Sliver ice
- Frozen soil
- Peat
- Gravel
- Open frost crack
- Ice-wedge troughs
- Road embankment

The diagram illustrates the evolution of ice wedges and their degradation stages. It is organized into a grid of 20 panels. The first column (UD, O1, O2, O3, O4) shows the progression of ice wedge degradation from undisturbed to complete. The subsequent columns (SA1, SA1a, SA1b, SA2a, SA2b, SA3a, SA3b, SA3c, SA4a, SA4b, SA4c, SA4d) show the stages of advanced stabilization. Arrows indicate the sequence of development, with a dashed arrow showing a transition from SA1 to SA3c. A legend at the bottom defines the symbols for water, terrestrial peat, silt and peat, gravelly sand, ice wedge, lacustrine peat and organic silt, permafrost table, thermokarst-cave ice, basal sediment-rich layer, ice wedge degradation, and ice wedge stabilization.

Legend:

- Water (W)
- Terrestrial peat (P)
- Silt and peat (SP)
- Gravelly sand (GS)
- Ice wedge (IW)
- Lacustrine peat and organic silt (LP)
- Permafrost table (PT)
- Thermokarst-cave ice, basal sediment-rich layer (TC)
- Thermokarst-cave ice, clear (TC)
- Ice wedge degradation (red arrow)
- Ice wedge stabilization (blue arrow)

A. Pre-Road
Prudhoe Bay region (1970s)

low-centered polygons

II. Climate change, no road
Jorgenson site (1949-present)

C. Climate change and road dust
Colleen site, T1 (1949-present)

D. Climate change, road dust, and flooding
Colleen site, T2 (1949-present)

transitional polygons

high-centered polygons

Drainage away from road

Drainage toward road

Increasing cumulative impacts

Mixed tundra	Heath/low shrub tundra (shaded)	Shaded Run	Stream/river
Wet tundra	Shrub/low shrub tundra (dark)	Water	Ice Ridge
Alpine tundra	Heath/low shrub tundra (dark)		Active Light

Walker et al. 2021 in prep. *Arctic Science*.

Infrastructure scenarios

Node and network:
Prudhoe Bay Oilfield



subhankarbanerjee.org

Corridor:
Dalton Highway



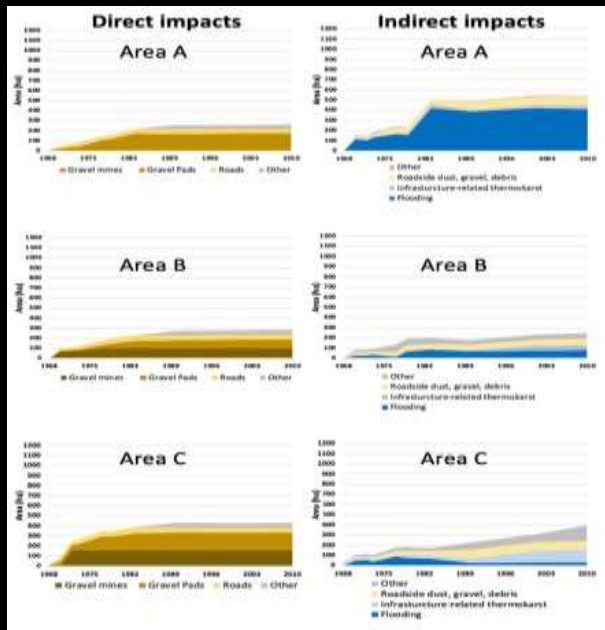
motorcycle-usa.com

Village:
Point Lay

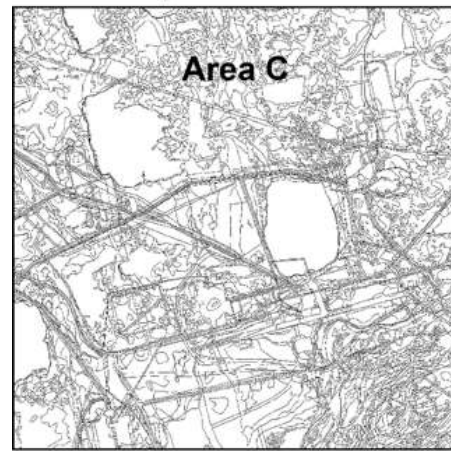


AlaskaTeenMedia

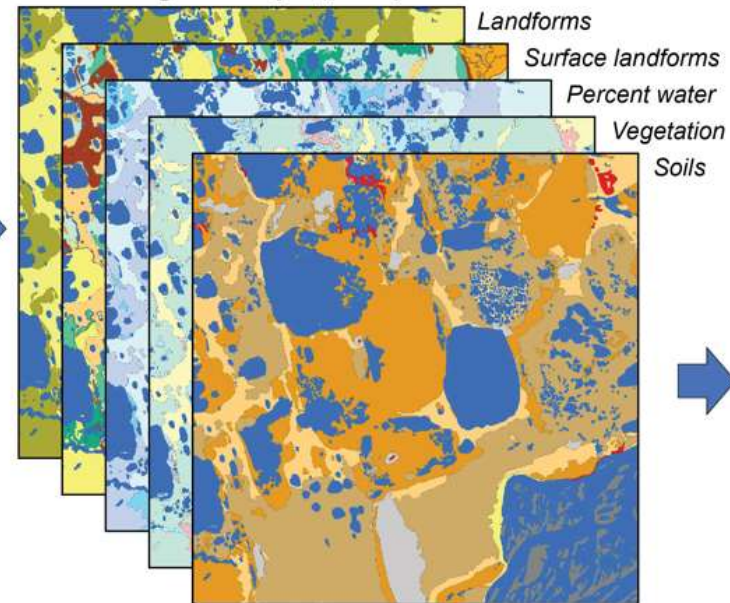
Landscape scale: Integrated geoeological and historical-change mapping



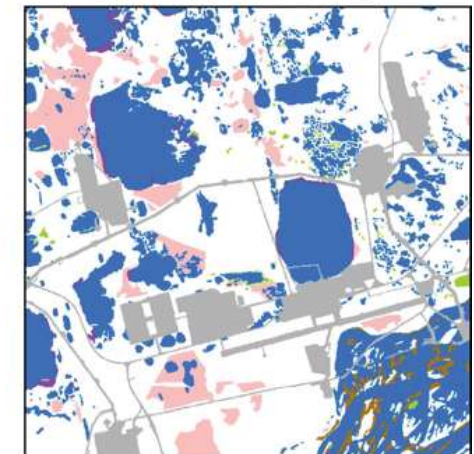
Master map



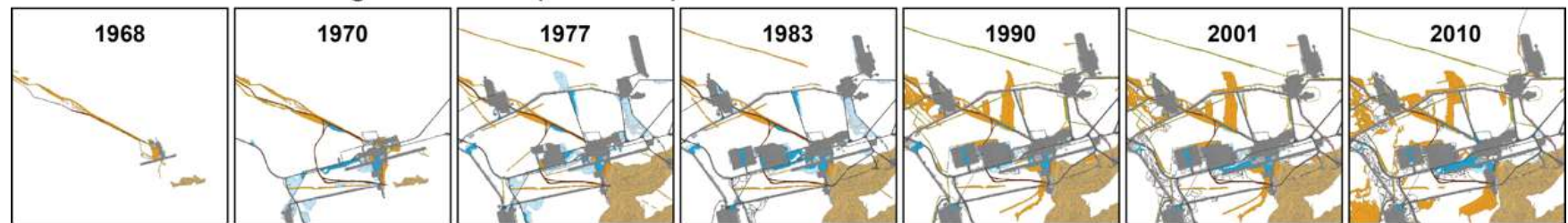
Geoeological maps (1949)



Non-infrastructure-related change map (1949-2010)

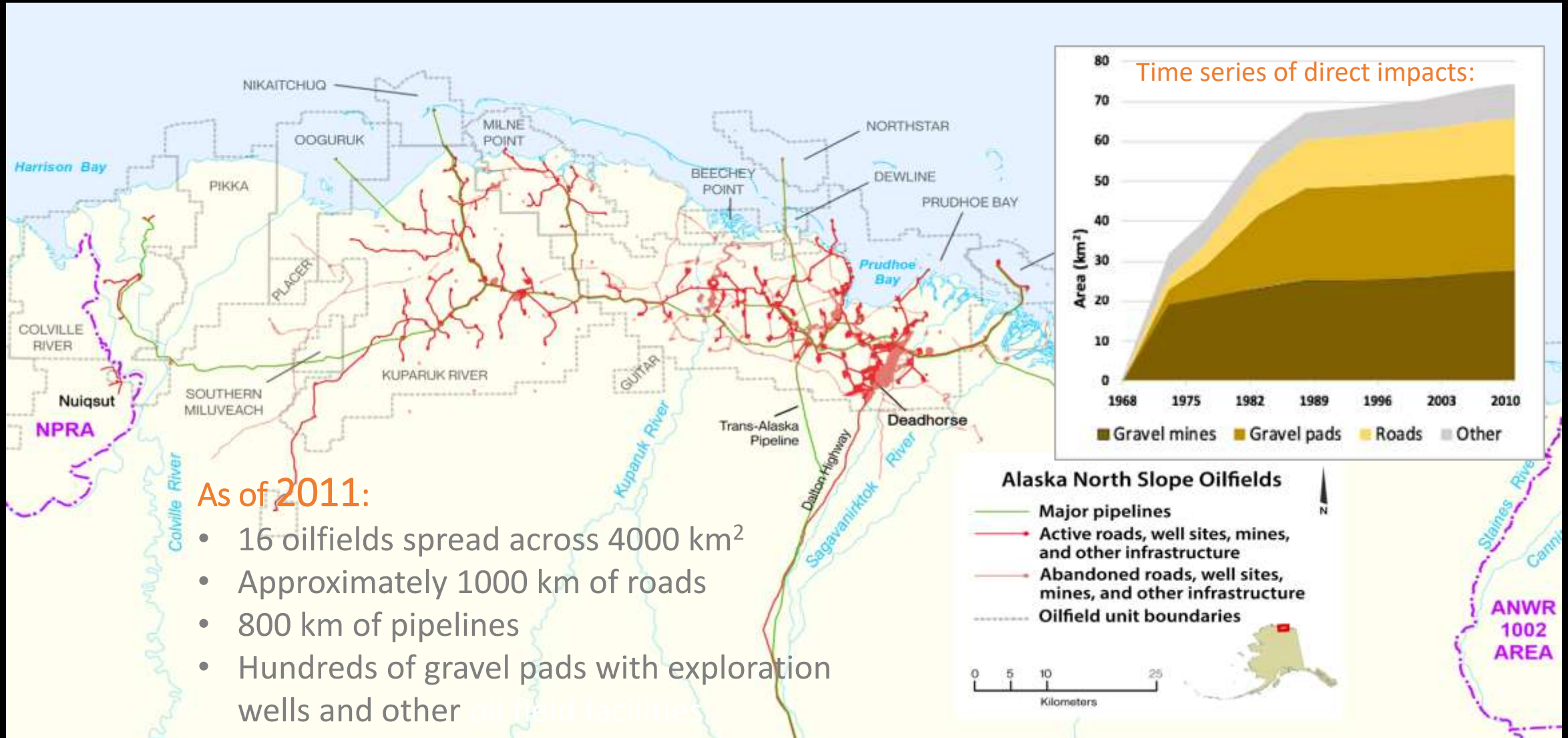


Infrastructure-related change time series (1968-2010)

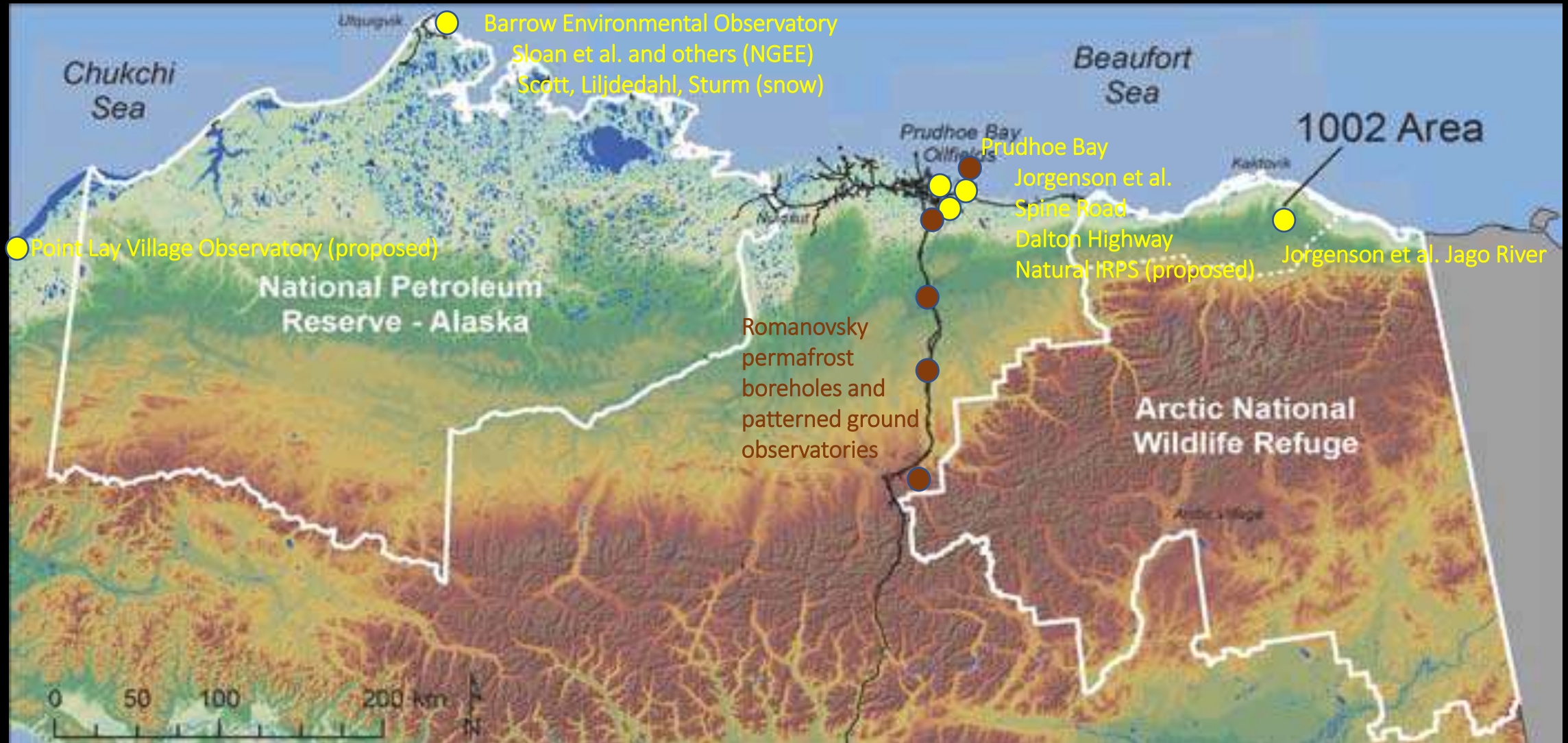


Historical change analysis: Raynolds et al. (2014) *Global Change Biology*, 20: 1211–1224

Regional scale time series of infrastructure: North Slope, Alaska, infrastructure since 1968

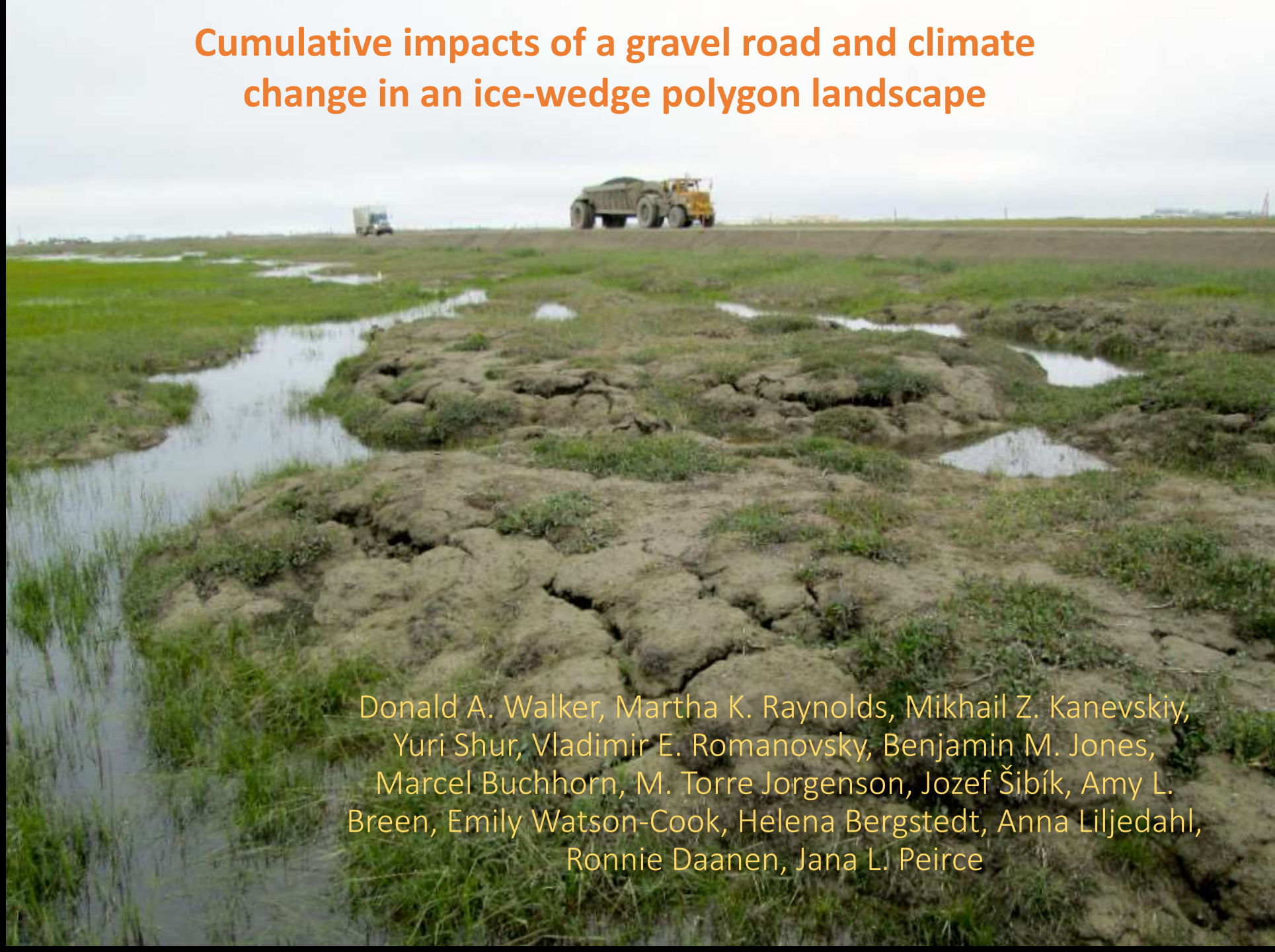


Sharing of information with other NNA and RATIC projects through Zoom meetings



Oral Talk Session ID19

Cumulative impacts of a gravel road and climate change in an ice-wedge polygon landscape

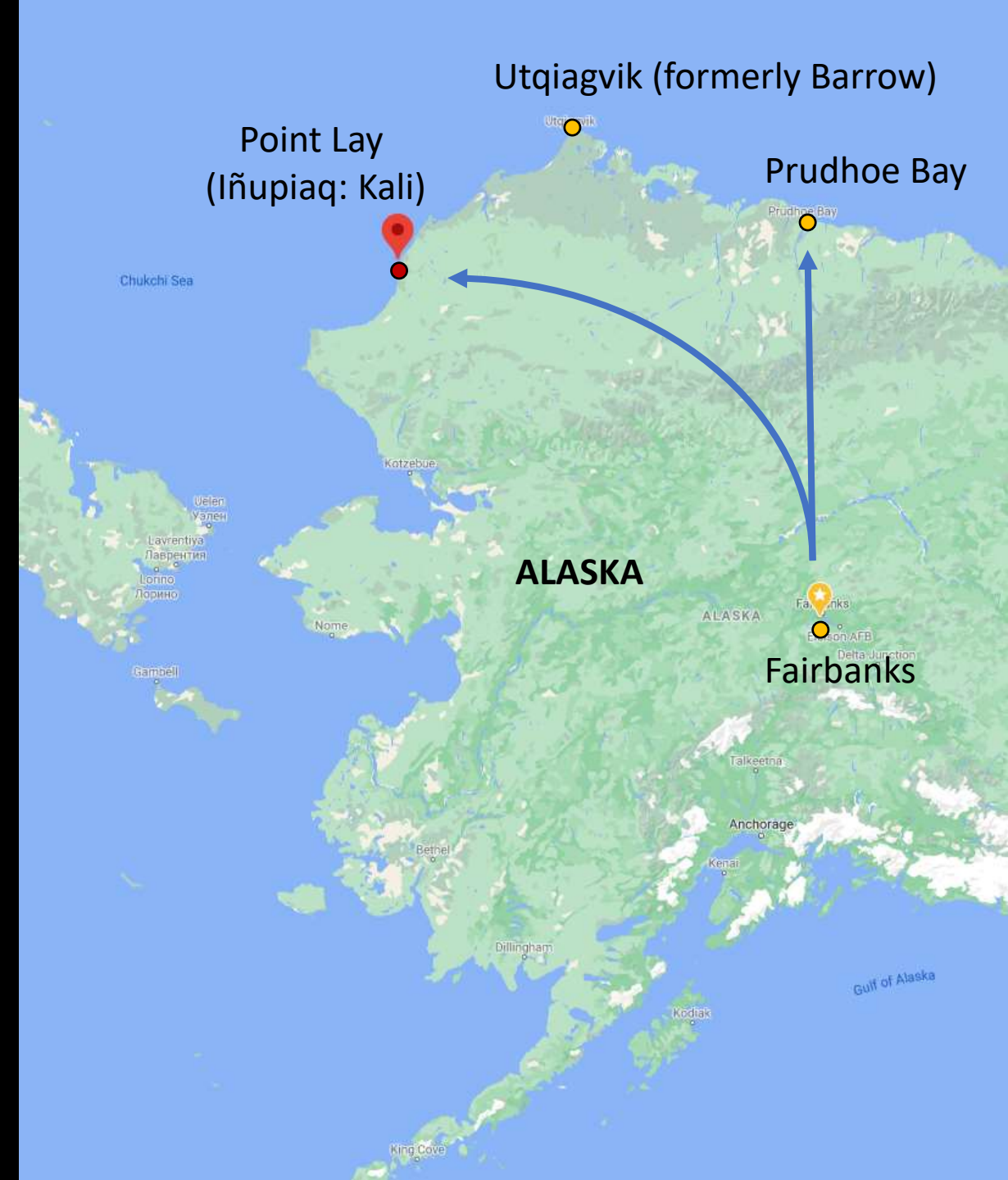


ASSW 2021,
Session ID19, Northern
Roads and Railways: Social
and Environmental Effects
of Transport Infrastructure
Thu 8 AM GMT

Donald A. Walker, Martha K. Raynolds, Mikhail Z. Kanevskiy,
Yuri Shur, Vladimir E. Romanovsky, Benjamin M. Jones,
Marcel Buchhorn, M. Torre Jorgenson, Jozef Šibík, Amy L.
Breen, Emily Watson-Cook, Helena Bergstedt, Anna Liljedahl,
Ronnie Daanen, Jana L. Peirce

Adapting to Change in Point Lay, Alaska (Kali)

- 230 people (~90% Iñupiat)
- Median age is 22! (over 100 students)
- Already relocated twice
- “Ground Zero for climate change on the North Slope”



Primary Research Question:

What are the best solutions for housing foundations in Point Lay where thaw subsidence is extreme?

- What has been tried?
- What has worked well? What hasn't?
- What can we learn from other places in the Arctic with ice-rich permafrost?



Research Partner:

Cold Climate Housing Research Center (CCHRC),
National Renewable Energy Laboratory (NREL)

Photos: CCHRC





October 2019 reception in Fairbanks with project partners
in town for the Alaska Federation of Natives (AFN)

Coordination, Collaboration, Co-development

Jana Peirce
Project Coordinator



3-minute video to introduce ourselves
to community (CCHRC)

Community Partners

Research

**Cold Climate Housing
Research Center (CCHRC)**

**UAF Institute of Northern
Engineering (INE)**

Outreach

**Ukpeagvik Iñupiat
Corporation Science
(UIC Science)**

Village

Tribal Government

Tribal President**

Village Liaison

Steering Committee

Tribal Council

Residents

Kali School

NSB School District

School Principal**

Teachers

Students

Cully Corporation

President/CEO*

Consultant

Regional

**Tagiugmiullu Nunamiullu Housing
Authority (TNHA)**

Executive Director**

TNHA Staff

North Slope Borough

**Dept. of Planning & Community
Services Director****

Capital Improvement Projects

Public Works, Water and Sewer Dept.

UIC Science

Outreach & Engagement Manager**

**Inupiat Community of the Arctic
Slope (ICAS)**

Executive Director

Environmental/Natural Resources

Director**

Orange = more active collaboration

** = Advisory Group member

Framework for Collaboration

- *Seek to build trust and mutual respect in our relationships by working to increase equity.*
- *Recognize that no one person's information or knowledge is more important than others.*
- **Village Liaison:** Main point of contact for project. Will receive an annual stipend equivalent to about 2 weeks work. Selected by the Tribal Council.
- **Local Steering Committee:** Identify best methods for working with community members and ways residents can participate in research. Four members selected by the Tribe, paid per meeting.
- **Advisory Group:** Meets several times a year by Zoom to help guide overall direction of the project (unpaid):
 - Review progress and work plans
 - Prioritize questions local & regional leaders/planners need answers to
 - Identify collaborative and educational opportunities
 - Advise on work products to ensure they meet the local/regional needs
 - Evaluate project at conclusion on its success in producing actionable science.
- **Project Coordination Agreement or MOA:** Developed with Village Liaison, approved by the Tribal Council. Includes agreed on compensation rates.
- **Subcontract with Tribe:** Identify roles and services the Tribe has the interest and capacity to provide and budget for it.

Factors for Success

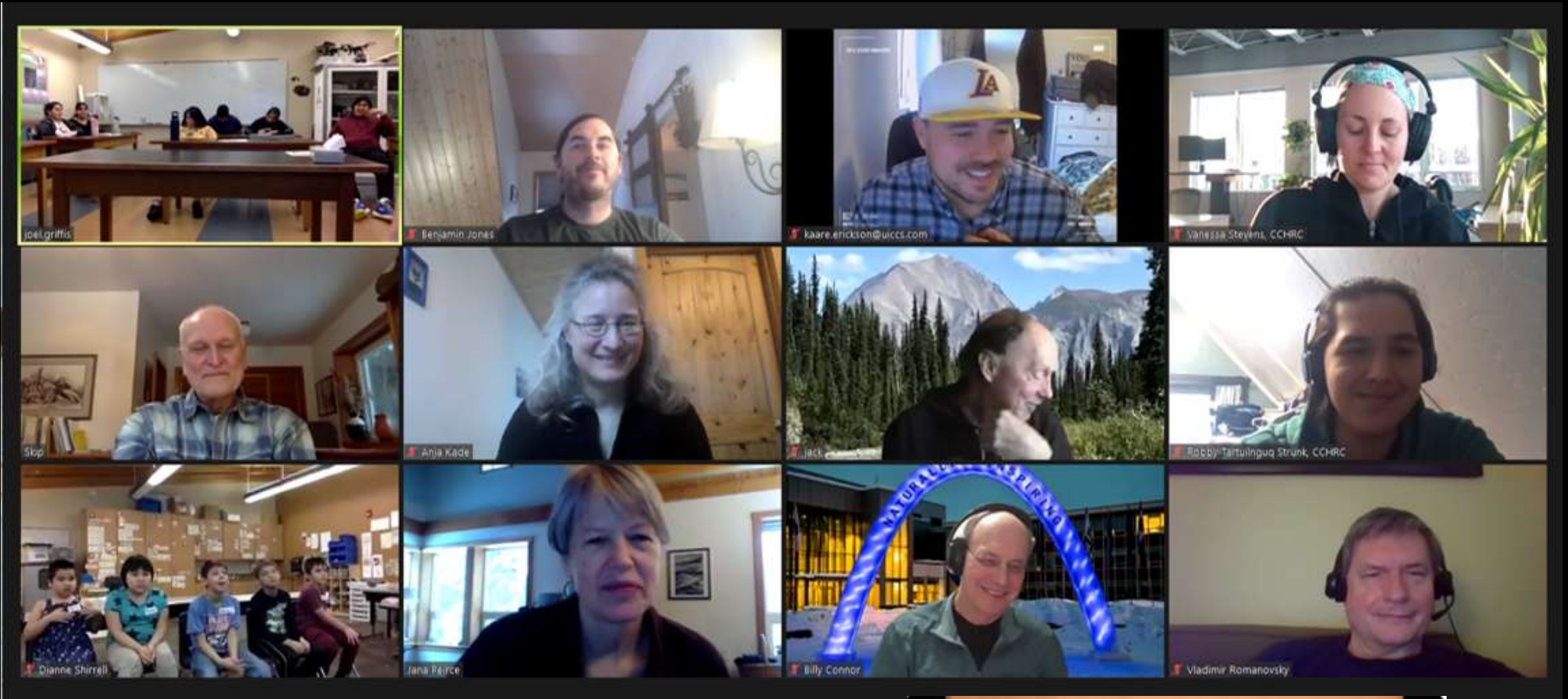
People are happy to work with the “Permafrost People.”

— Pearl Neakok, 1st Village Liaison

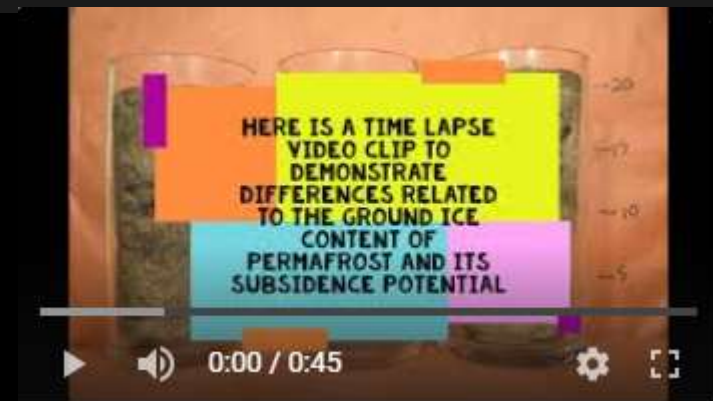


- **Start with a research question that is driven by local needs and priorities.** The community has expressed strong support for partnering on this project because it addresses urgent health and safety challenges related to permafrost thaw.
- **Icebreakers first!** Before you do anything, introduce yourselves to the community. People will respond more quickly to a person than a project.
- **Project Coordination Agreement.** It encourages realistic and ethical framework for collaboration and puts it in writing. Especially good if the community has not adopted its own guidelines for researchers working on their land!
- **Pay your local partner(s):** It's more equitable if everyone is getting paid for their contributions (not just scientists).
- **Regional helpers:** UIC Science has helped us make connections.
- **Advisory Group:** The best thing we've done to understand local issues and perspectives during COVID. Four other research projects working in Point Lay have joined in the calls so we all benefit.

K-12 Outreach



Icebreaker: Classroom visit by Zoom
Scientists introduced themselves and shared “one cool thing.”





Exploring the New Arctic in Ex-100 Permafrost Systems. Grade 1 & 2 Miss Dianne Parker

Stowien

Words about permafrost and landscape change in the Arctic:

The vocabulary worksheet is for first and second grade students in Ms. Stowien's class to complete over the winter break. During the spring semester, students from the University of Alaska Fairbanks will join the class by video to tell about how the Arctic landscape is changing and the role played by permafrost and water.

Instructions:
Learn the vocabulary words related to permafrost and landscape change. If possible, interview an older family member or neighbor to learn if they know an Alaskan name or another local word to the same thing.

Picture	Word	Meaning	Alaskan or local word
	permafrost	Ground that remains frozen all year long. Permafrost is made of ice, soil, rocks, and sand, and may contain the remains of ancient plants and animals.	<i>Sigun</i>
	active layer	The top layer of soil above permafrost that thaws in summer and refreezes in the fall.	<i>Colt</i>
	weather	Day-to-day variations in local temperature, wind, rain and snow conditions.	<i>Alaska</i>
	climate	Typical weather patterns in a region measured over many years.	<i>Alaska</i>



Name Jayla

Ground that remains frozen all year long.
PERMAFROST is made of ice, soil, rocks, and sand, and may contain the remains of ancient plants and animals.




Grades 1-2
Permafrost vocabulary

Middle & High School



1st & 2nd Graders

EXPLORING SNOW



Did you know?

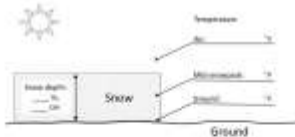
- Snow forms when there are crystals in the atmosphere.
- Snow crystals can have many different shapes.
- Snow traps air and is a good insulator. (Air does not keep the temperature of an object the same.)

Get ready!

- Draw around a snowflake, measuring tape and thermometer.
- Find an undisturbed patch of snow.
- Dig through the snow until you hit the ground; scrape out one inch of your hole.

Several measurements:

- With your thermometer, measure the temperature of:
 - the air above the snow
 - the snow in the middle of the snowpack
 - the ground below the snowpack
- Use the measuring tape to see how thick the snowpack is.
- Write your data in the lines in the diagram below.



• Look at the snow crystals. What shape can you find towards the top and bottom of the snowpack?

Think about it:

- Where did you find the lowest temperature?
- Where did you find the highest temperature?
- Some small animals spend the winter in or below the snowpack. Can you think of any?

Permafrost-related Activities

in collaboration with Kali teachers & principal

We study earth from the sky
Our research is called Remote Sensing. Cameras and sensors on

We study water in the Arctic

We design houses for cold places

We study permafrost

We study Arctic plants

Our questions:

Which plants are neighbors to each other in "plant communities"?

As the Arctic gets warmer, which plants are becoming more common and which harder to find?

How do we change which plants grow nearby when we build houses, roads and snow fences?

Which plants grow in Arctic lakes?

Which plants help protect the permafrost from thawing?



Dr. Skip Walker, UAF
Vegetation ecologist, Fairbanks



Dr. Amy Breen, UAF
Vegetation ecologist, Palmer



Dr. Anja Kade, UAF
Vegetation ecologist, Fairbanks



Emily Watson-Cook, UAF
Graduate student, Fairbanks

1st & 2nd Grade Bulletin Board

Sharing Back Data & Findings

From our Project Collaboration Agreement:

- Guided by CARE Principles for Indigenous Data Governance for handling, ownership, reporting, and archiving of all data collected in Point Lay.
- Data collected in Point Lay will be organized and delivered back to the community in a format the Tribal Council believes will be useful.
- The Tribal Council can share and use the data however they would like.
- To meet funding requirements and contribute to the advancement of scientific knowledge, researchers will publish papers, present research findings to the public, and archive data in open science data repositories.



www.gida-global.org/care