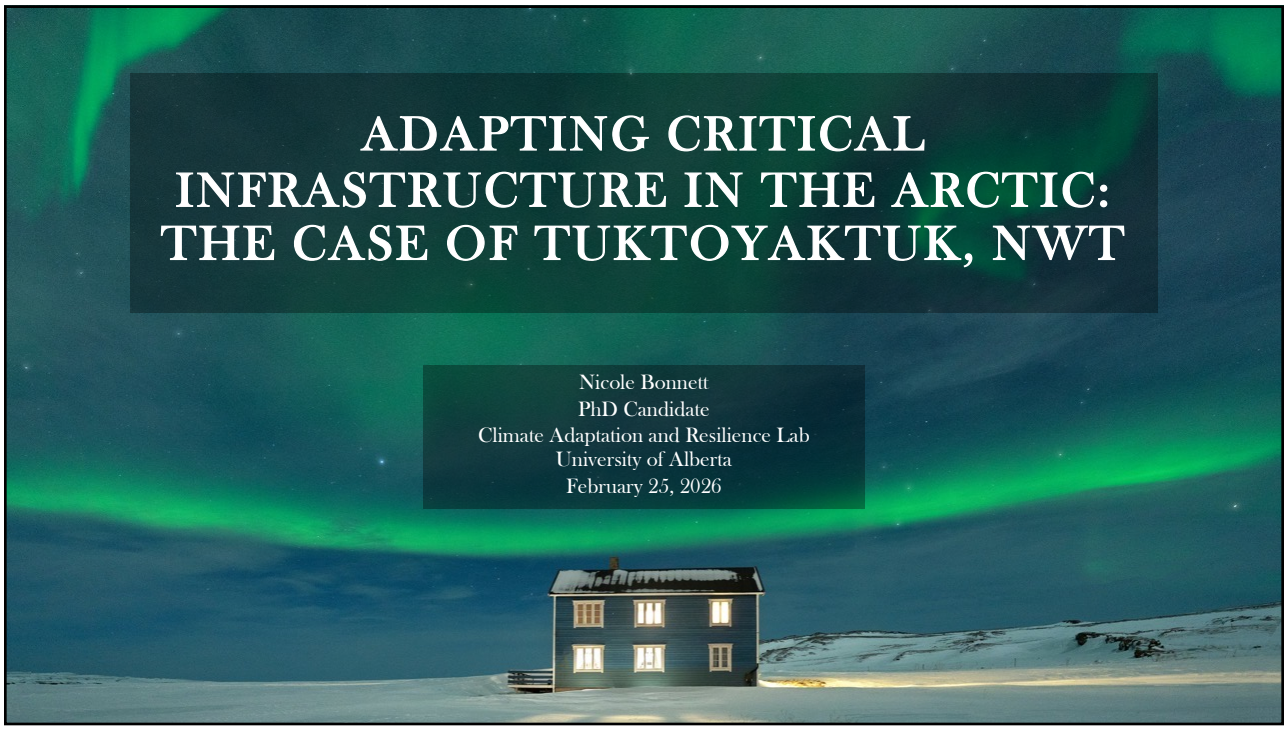
ADAPTING CRITICAL INFRASTRUCTURE IN THE ARCTIC: THE CASE OF TUKTOYAKTUK, NWT
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University of Alberta
February 25, 2026

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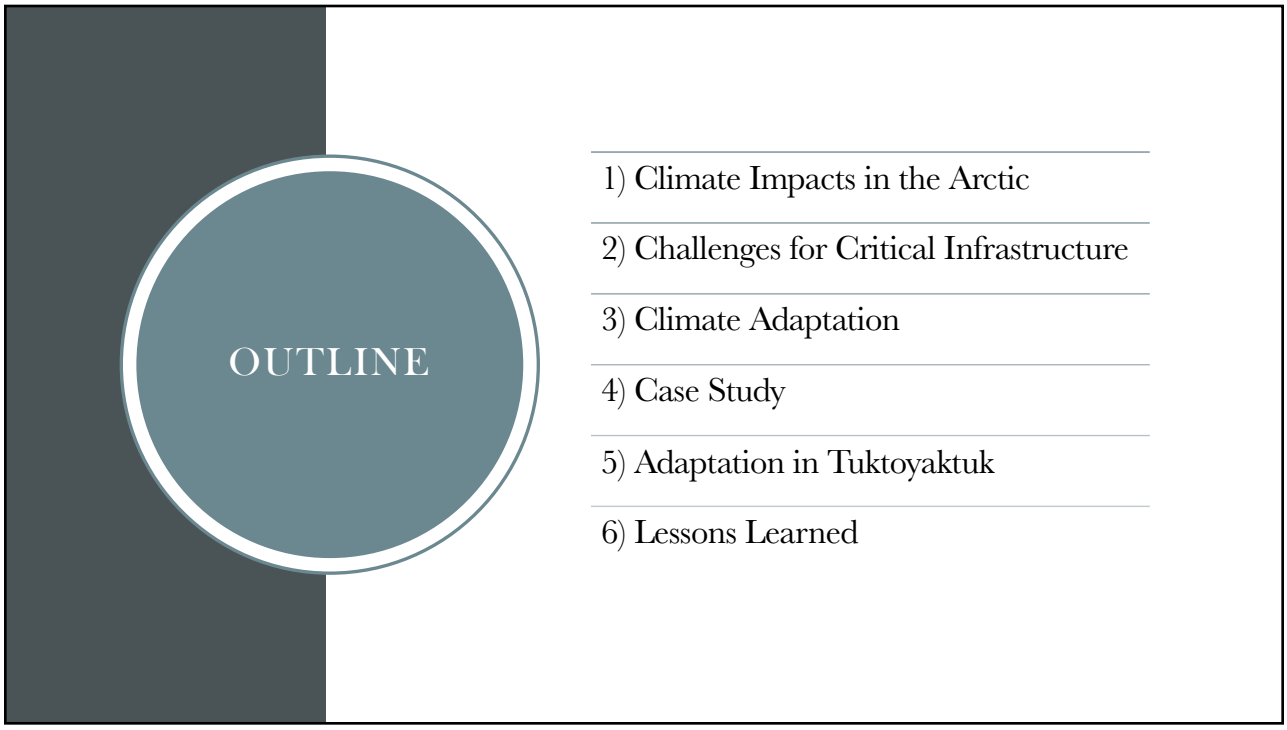
OUTLINE
1) Climate Impacts in the Arctic
2) Challenges for Critical Infrastructure
3) Climate Adaptation
4) Case Study
5) Adaptation in Tuktoyaktuk
6) Lessons Learned

2

DEFINING THE ARCTIC

- Various definitions of the Arctic exist:
  - Temperatures
  - Arctic Treeline
  - Permafrost Zones

3

DEFINING THE ARCTIC

"The polar region located approximately 66.5 degrees North of the equator" (Bonnett & Birchall, 2020, p. 1)

4

CLIMATE IMPACTS IN THE ARCTIC

- Warming at a rate of 4X the global average (Rantanen et al., 2022)
  - Permafrost thaw
  - Erosion
  - Flooding
  - Wildfire
  - Extreme weather events

5

CHALLENGES FOR CRITICAL INFRASTRUCTURE

6

CLIMATE RELATED CHALLENGES

"Not many things give me stress or anxiety or keep me up at night, but climate change is the one thing that makes me a little bit worried" (DC6).

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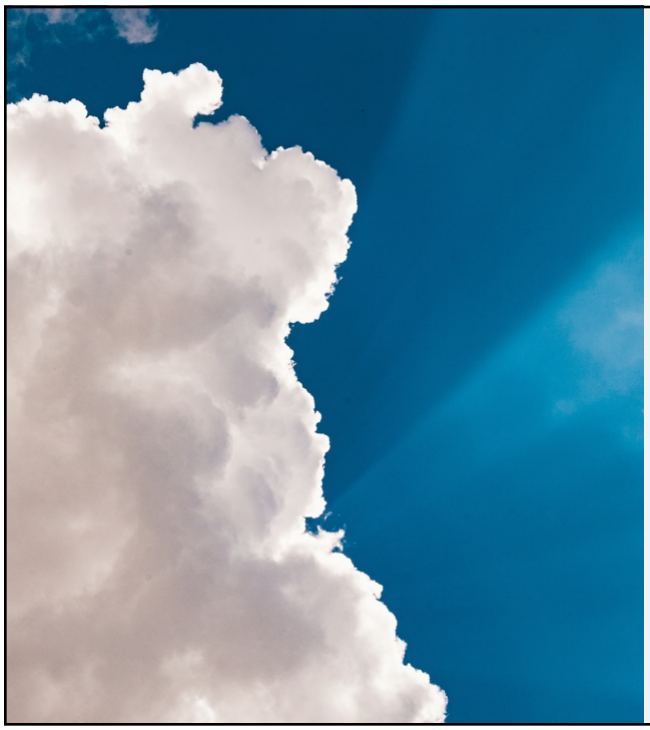

CLIMATE CHANGE RESPONSES

Mitigation

Adaptation

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CLIMATE ADAPTATION

Adaptation strategies can be broken down into (Doberstein et al., 2019):

1. **P**rotect
2. **A**ccommodate
3. **R**etreat
4. **A**void

PARA Framework

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CLIMATE ADAPTATION

Adaptation strategies can be broken down into (Bonnett & Birchall, 2020):

1. Structural
2. Non-Structural
3. Ecosystem-Based

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CASE STUDY

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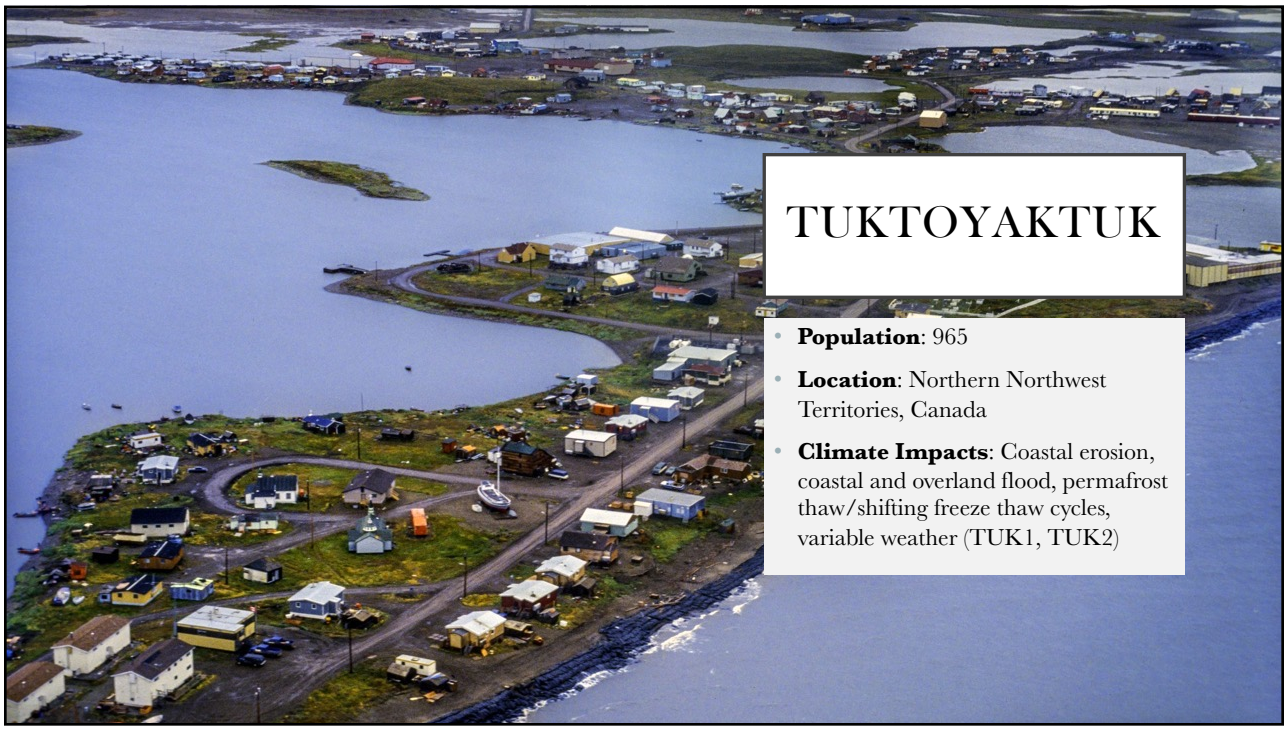

TUKTOYAKTUK

- **Population**: 965
- **Location**: Northern Northwest Territories, Canada
- **Climate Impacts**: Coastal erosion, coastal and overland flood, permafrost thaw/shifting freeze thaw cycles, variable weather (TUK1, TUK2)

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INFRASTRUCTURE IN TUK

- **Transportation**
  - Inuvik-Tuk highway, airport
- **Water & Sanitation**
  - Water treatment plant, Tuktoyaktuk dump
- **Healthcare**
  - Tuktoyaktuk health center
- **Safety**
  - Shoreline armoring and rip rap

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CLIMATE CHALLENGES IN TUK

- Dynamic and interrelated coastal impacts (Lim et al., 2020):
  - Wave action
  - Storm surge
  - Permafrost thaw
  - Ground subsidence
  - Sea level rise

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ADAPTATION IN TUK
Tuk has been pursuing an adaptation agenda for more than four decades!

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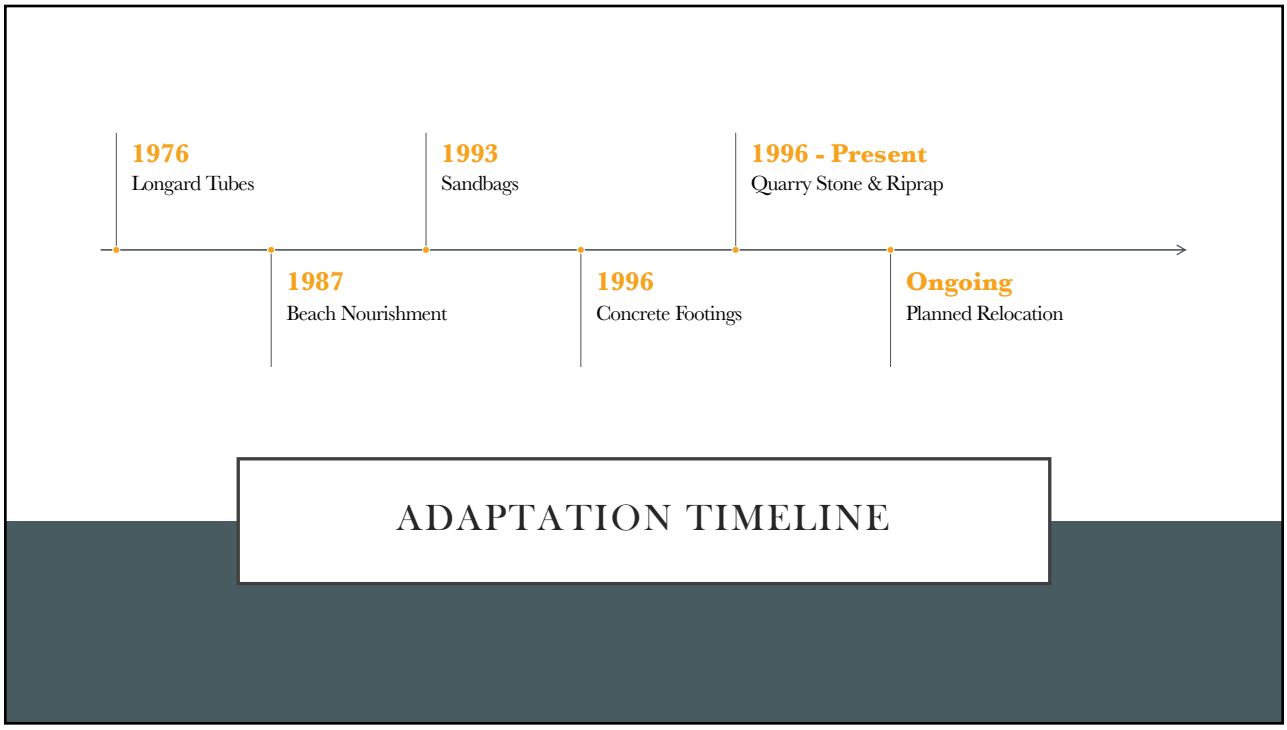
1976
Longard Tubes
1987
Beach Nourishment
1993
Sandbags
1996
Concrete Footings
1996 - Present
Quarry Stone & Riprap
Ongoing
Planned Relocation
ADAPTATION TIMELINE

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1976: LONGARD TUBES

- Sand-filled synthetic fibre tubes (Future Tuktoyaktuk, n.d)
- Protect the shore and slow longshore transport
- Destroyed in 1981

17

1987: BEACH NOURISHMENT

- "Feed the Ocean" (Future Tuktoyaktuk, n.d)
- Replenishing sand and gravel
- Abandoned in 1993

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1993: SANDBAGS

- Placed behind the cemetery
- Provide their own slow-leak beach nourishment as they break open
- Not well maintained and lost in 1997 to a severe storm

19

1996: CONCRETE FOOTINGS

- Concrete blocks measuring 1 m x 1 m x 0.25 m (Future Tuktoyaktuk, n.d)
- Undermined the following year by storms

20

1996: QUARRY STONE & RIPRAP

21

DOWNFALLS OF STRUCTURAL ADAPTATION

Structural adaptations are no longer able to cope with the frequency and severity of climate impacts (Bonnett & Birchall, 2020)

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PLANNED RELOCATION

- Relocation:
  - Involves the physical movement of livelihoods, homes, and infrastructure out of hazard prone locations and into safer and more suitable areas
  - Requires proactive and rigorous planning, meaningful engagement, cooperation with all levels of government, and sustained political will (Bonnett & Birchall, 2025)

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RELOCATION IN TUK

- Structural measures are used to buy the community more time to plan for relocation
  - Integrating relocation goals into local planning tools
  - Developing a relocation plan
  - Incrementally implementing relocation
- Reindeer Point was selected as the resettlement site, and five homes and a school have been relocated

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RELOCATION CHALLENGES

- Barriers:
  - Policy direction
  - Community consultation
  - Land claims
  - Enough space in resettlement site

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WHAT CAN WE LEARN FROM TUK?

- Short term structural adaptations are increasingly incapable of protecting infrastructure from more frequent and severe climate impacts
- Relocation offers a long-term solution to growing vulnerability
- Relocation is incredibly complex and associated with a range of unique barriers

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WHAT CAN WE DO MOVING FORWARD?

- AVOID: Prevent the location of critical infrastructure in hazard prone locations to begin with
- ACCOMMODATE: Adjust land use planning tools to account for growing climate risk
- RETREAT: Proactively retreat from hazard prone locations (rolling easement, home buyout programs)

- It's not about getting it right the first try: it's about learning, making adjustments, and remaining committed over time.

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THANK YOU!

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