RATIC
Rapid Arctic Transitions due to Infrastructure and Climate

RATIC – T-MOSAiC
connections and opportunities

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Brief background

RATIC workshop overview
RATIC Background

• Forum for developing and sharing new ideas and methods regarding sustainable development in the face of rapid Arctic Change

• Workshops:
  • Arctic Change 2014, Ottawa, Canada
  • ICARP III, 2015, Yohama, Japan

White paper with major messages and conclusions

Social and Human
- Cumulative impacts of RATIC to subsistence and culture
- Analysis of historical indigenous infrastructure adaptations to climate change
- IRPS issues related to global economy and global security
- Legal framework, state and federal regulations
- Social, economic, political & technological drivers of IRPS change
- Adaptive management approaches to mitigate adverse change

Terrestrial
- Terrestrial ecosystem responses to changes in land/air temperatures, hydrology, permafrost snow, & contaminants
- Monitoring IRPS change at multiple scales
- Predictive models of IRPS change
- Input to engineering, land-use planning and adaptive management responses

Cryosphere
- Permafrost thawing and its associated impacts on natural and built environment
- Sea-ice response to warming climate
- Modeling permafrost and sea-ice response, and engineering implications

Marine
- Implications of industrial infrastructure to marine and sea-ice ecological, and social subsystems
- Implications of changes in marine transport
- Monitoring sea-ice changes to marine transport, off-shore & on-shore infrastructure, developments
- Implications to global marine systems

Atmosphere
- Climate drivers of change to terrestrial and marine subsystems
- Atmospheric contaminants, black carbon, dust
- Implications to global climate system

ICARP III
Priority 3: Sustainable development

AT ICARP III, RATIC was conceived as a cross-cutting initiative involving all five IASC working groups to address topics related to sustainable development in ice-rich permafrost systems.
Sustainable Arctic Infrastructure Forum (SAIF)
An RATIC Cross-cutting Workshop
Arctic Science Summit Week 2017, Prague

Toward a RATIC strategy document and RATIC publications
Thirty-nine participants, mainly from the TWG and S&HWG
ASSW 2019
T-MOSAiC Session, May 25
RATIC workshop, May 26

**RATIC – T-MOSAiC connections and opportunities**

- Collaboration with T-MOSAiC and its systems level themes of connectivity, gradients, discontinuities and thresholds, feedbacks, extreme events, legacy effects and emergent properties.

- We especially encourage IASC Fellows, APECS members, Indigenous people, and industry representatives to participate.
Conceptual thematic diagrams

T-MOSAiC–MOSAiC

Major area of overlap is coastal environment Where most Arctic infrastructure is located.

Original RATIC

Linkages are strongest between TWG, SHWG, and CWG

Navigating the New Arctic (NNA)

Infrastructure and sustainable development important
T-MOSAiC Terrestrial Multidisciplinary distributed Observatories for the Study of Arctic Connections

- Forum for developing and sharing new ideas and methods regarding sustainable development in the face of rapid Arctic change.

How to link RATIC and T-MOSAiC?

Pan-Arctic, land-based program that would extend the activities that are currently in MOSAiC.
Social environment
- Cumulative impacts of RATIC to subsistence and culture
- Analysis of historical indigenous infrastructure adaptations to climate change
- Social, economic, political & technological drivers of IRPS change
- Adaptive management of climate and infrastructure changes

Natural environment
- Documenting ice-rich permafrost system response to climate warming and changes to infrastructure
- Monitoring terrestrial ecosystem responses to changes in land/air temperatures, hydrology, permafrost snow & contaminants at multiple scales
- Predictive ecosystem models of IRPS change

Built environment
- Documenting and monitoring infrastructure response to climate warming
- Engineering solutions for infrastructure in urban nodes, remote villages, corridors
- Adaptive engineering solutions that include consideration of local culture, and indigenous knowledge

RATIC is focused at the interface between the Social, Built, and Natural Terrestrial Environments.
Effects of climate change and infrastructure on Ice-rich-permafrost systems (IRPS)

- **Infrastructure**
  - Roads
  - Gravel pads
  - Pipelines
  - Gravel mines
  - Seismic lines
  - Off-road trails

- **Regional climate**
  - Mean annual temperature
  - Summer warmth
  - Summer precipitation
  - Snowfall

- **Ground ice**
  - Permafrost temperature
  - Active-layer thickness
  - Ice content
  - Cryostructure

- **Landforms**
  - Micro-topography
  - Periglacial landforms

- **Soils**
  - Soil moisture
  - Texture
  - Organic layer thickness
  - pH
  - Nutrients

- **Micro-climate**
  - Ground temperature

- **Vegetation**
  - Species diversity
  - Canopy structure
  - Thickness of moss layer
  - Phenology

- **Snow**
  - Depth
  - Hardness
  - Phenology

- **Hydrology**
  - Water depth
  - Temperature
  - Velocity

- **Other biota**
  - Microbes
  - Insects
  - Birds
  - Mammals
  - Fish

- **Soils**
  - Soil moisture
  - Texture
  - Organic layer thickness
  - pH
  - Nutrients

- **Micro-climate**
  - Ground temperature

- **Walker et al. 2015. AGC 151.**

- **The Grapes. 2012. flickr.**
Thermokarst collapse due to flooding
Dalton Highway 2015

Shur et al. 2016. TICOP and in prep.

Underground thermal erosion of ice wedges
Photos: Courtesy of AKDOT & PF.
ArcSEES roadside observatories

- Aerial photo time series
- Transect surveys
  - Micro-topography
  - Permafrost cores
  - Active layer
- Vegetation
- Soil
- Snow
- Dust
- Flooding
Housing adaptations to changing permafrost regimes

Adaptations at Point Lay, Alaska

Photos courtesy of the Cold Climate Housing Research Center, Fairbanks
RATIC Workshop Agenda, 26 May

9:00  Welcome and introductions
9:20  Presentations: Impacts and interactions of climate and infrastructure in the Arctic
10:30 Coffee and posters
11:00 Presentations: Approaches to research and adaptation
13:00 Lunch
14:00 Research directions: Prague workshop synthesis
14:20 Breakout groups: Natural, social and built environment perspectives on research needs
15:30 Coffee and posters
16:00 Research priorities: Report from breakout groups
16:30 Linkages and opportunities: Working across disciplines and geographic boundaries
17:30 RATIC 2020: Planning the next steps
18:00 Adjourn