Workshop Report to the IASC Secretariat

Sustainable Arctic Infrastructure Forum (SAIF)

An IASC Cross-cutting Workshop

Arctic Science Summit Week 2017
Clarion Congress Hotel, Prague, Czech Republic, 3 April 2017

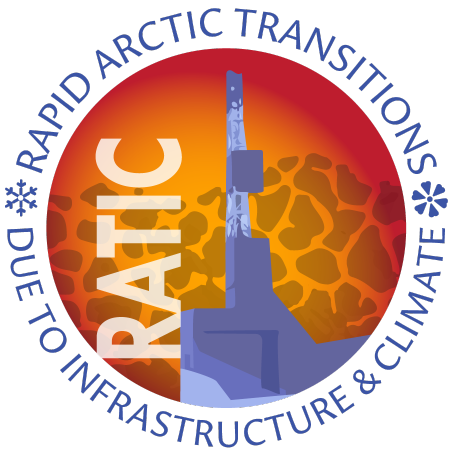
By D.A. “Skip” Walker

26 April 2017

Co-applicants:

TWG: Lead contact: Donald A. (Skip) Walker dawalker@alaska.edu; Vladimir Romanovsky veromanovsky@alaska.edu; Warwick F. Vincent Warwick.Vincent@fsg.ulaval.ca; Josef Elster jelster@butbn.cas.cz; Scott Zolkos (2016 Fellow) zolkos@ualberta.ca; Josefine Lenz (2015 Fellow) josefine.lenz@awi.de.
SHWG: Peter Schweitzer peter.schweitzer@univie.ac.at; Gail Fondahl Gail.Fondahl@unbc.ca; Andrey Petrov andrey.petrov@uni.edu.
CWG: Annette Bartsch Annett.Bartsch@zamg.ac.at; Hugues Lantuit Hugues.lantuit@awi.de; Elena Kuznetsova (2014 Fellow) elena.kuznetsova@ntnu.no; Louis-Philippe Roy (2014 Fellow) lroy@yukoncollege.yk.ca.
MWG: Lee Cooper cooper@cbl.umces.edu; Hajime Yamaguchi h-yama@edu.k.u-tokyo.ac.jp.

Sustainable Arctic Infrastructure Forum (SAIF)



An activity of the Rapid Arctic Transitions due to Infrastructure and Climate (RATIC) initiative

Arctic Science Summit Week 2017

Clarion Congress Hotel
Aquarius Room

Prague, Czech Republic

3 April 2017

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Financial support for this workshop came from International Arctic Science Committee (IASC) Secretariat, the U.S. National Aeronautics and Space Administration (NASA) Land-Cover and Land-Use Change Program (Grant No. NNX09AK56G), the NASA Arctic-Boreal Vulnerability Experiment (ABoVE) (Grant No. NNX14A0905) and the U.S. National Science Foundation's Arctic Science Engineering and Education for Sustainability initiative (NSF ArcSEES, Grant No. 1263854 with partial support from the Bureau of Ocean Energy Management). Administrative support came from IASC, and the University of Alaska Fairbanks, Institute of Arctic Biology.

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AGENDA

Monday, 3 April – Clarion Congress Hotel, Aquarius Room, Prague

MORNING: Welcome, goals for the workshop, brief orientation talks, student keynote, and charge for the workshop

Facilitator – Jana Peirce

09:00 **Welcome, introduction of participants:** *Elena Kuznetsova*

09:15 **Logistics:** *Jana Peirce*

09:25 **RATIC and goals of the workshop:** *Skip Walker*

09:45 **Ecological effects of infrastructure and its impacts on reindeer herding:** *Timo Kumpula*

10:05 **Social effects of infrastructure:** *Peter Schweitzer*

10:25 **Adaptive management and cumulative effects:** *Gary Kofinas*

10:45 **Coffee Break**

11:00 **Keynote student presentation:** "Cumulative effects of environmental change on culturally significant ecosystems in the Inuvialuit settlement region": *William Tyson*

11:20 **Charge for the workshop:** *Skip Walker*

11:40 **Breakout groups by infrastructure systems (discussion leaders)**

- Indigenous infrastructure: camps, trails, corrals, migration corridors (Otto Habeck, Gary Kofinas)
- Onshore oil and gas fields (Skip Walker, Timo Kumpula)
- Remote communities (Warwick Vincent)
- Corridors: roads, railways, pipeline (Peter Schweitzer)
- *Cities (Nikolay Shiklomanov, Dmitry Streletskiy) - discussion on 6 April

13:00 **Lunch and Posters (Light lunch provided)**

Students and others are invited to bring RATIC-related posters to present. (Note: We don't know how much space will be available to display posters, so if you are creating a poster especially for the workshop, we recommend sizes no larger than 90 x 120 cm.)

AFTERNOON

14:00 **Continue breakout groups**

15:30 **Plenary to present breakout groups 1 & 2 results**

16:00 **Coffee Break**

16:15 **Plenary to present breakout groups 3 & 4 results**

16:45 **Discussion of journal publication**

17:15 **How to organize results of workshop into a RATIC strategy document**

Workshop Summary Report

Summary statement

The Sustainable Arctic Infrastructure Forum (SAIF) was an IASC cross-cutting workshop involving principally the IASC Terrestrial, Social and Human, and Cryosphere working groups. The forum occurred 3 April, during Arctic Science Summit Week 2017, in Prague, Czech Republic. Eleven related scientific papers and six posters were presented during the Science Session 17.3 "Rapid Arctic Transitions due to Infrastructure and Climate (RATIC)". SAIF is an activity of the IASC RATIC initiative. Thirty-nine individuals participated in the SAIF workshop. The program consisted of: (1) a series of introductory talks, (2) a keynote student presentation by Will Tyson, (3) breakout sessions to address scientific and policy issues related to major types of infrastructure, and (4) discussion to address a journal publication and a RATIC strategy document. The major task of SAIF was to address the cumulative effects of four major types of infrastructure systems: indigenous infrastructure (e.g., camps, trails, corrals, migration corridors, etc.); onshore oil & gas fields (networks of roads, drilling and facility pads, pipelines, etc.); remote communities (village infrastructure); and urban infrastructure (cities). Plans for publication of the results from the forum are to summarize the results from the breakout groups, identify the science questions and policy issues that were common to all types of infrastructure and those that were unique to one or two types, and develop a strategy for addressing the questions and issues based on the tools, approaches and institutions identified by each breakout group. "Corridors" and "nodes" emerged as an organizing framework for developing research themes related to the various types of infrastructure. A "Prague Sustainable Infrastructure Scientific Research Agenda" identified the following tasks to be completed by RATIC in the next five years: (1) Promote the topic of "sustainable infrastructure development" as a key IASC research theme; (2) involve scientists, local communities, governments, industry and the general public in this research; (3) publish a synthesis of sustainable Arctic infrastructure research findings in peer-reviewed scientific journals and more publicly accessible platforms; (4) pursue funding to continue the RATIC initiative; and (5) develop a strategic plan by December 2017.

Introduction

The major task of the Sustainable Arctic Infrastructure Forum (SAIF) was to address the cumulative effects of infrastructure and climate change as they relate to major types of infrastructure systems.

The forum was attended by 39 participants (Appendix A), and consisted of three major pieces: (1) A series of introductory talks and keynote student presentation, (2) Breakout groups to address scientific and policy issues related to various types of infrastructure, and (3) Discussion to address publications and a RATIC strategy document.

Introductory talks and keynote student presentation

Introductory talks by Skip Walker, Timo Kumpula, Peter Schweitzer, and Gary Kofinas set the stage for the meeting. A keynote talk by Will Tyson titled "Cumulative effects of environmental change on culturally significant ecosystems in the Inuvialuit settlement region" provided an example of an approach to address the issue of cumulative climate and infrastructure effects over a large Arctic region of Canada. Abstracts of the introductory talks and keynote student presentation are in Appendix B.

Breakout groups to address major infrastructure systems

Arctic infrastructure comes in many different forms and sizes from the camps, trails, and migration corridors of indigenous people to urban infrastructure of cities and networks of roads, pipelines, powerlines, and construction camps associated with oil and gas development. Certain forms of physical infrastructure are a precondition for contemporary life in the Arctic, while others do not seem to benefit local residents. Thus, the question about sustainable infrastructure development and maintenance involves choices, costs, and benefits.

Major types of Infrastructure systems:

- Indigenous infrastructure (e.g., camps, trails, corrals, migration corridors, etc.)
- Onshore oil & gas fields (networks of roads, drilling and facility pads, pipelines, etc.
- Remote communities (village infrastructure)
- Infrastructure corridors (long highways, railroads, pipelines)
- Urban infrastructure (cities)* Mining and smelting
- * Offshore oil & gas

  **Not addressed in this workshop*

Workshop participants joined one of five breakout groups to discuss the cumulative effects and interactions with climate change of one of the first four infrastructure systems listed above. An urban infrastructure discussion took place on 6 April with Dmitri Streletskiy and Kolia Shiklomanov. Each group addressed a series of questions that addressed: (1) Background, (2) Description of the infrastructure system, drivers and effects of change, (3) Vulnerability and resilience, (4) Key Science questions, (5) Key policy issues, and (6) Tools, approaches and institutions.

Each group deliberated for approximately three hours. The rapporteurs then summarized the results in six Powerpoint slides. The results are currently being summarized and will form the basis of a publication.

Breakout-Group Questions

Background (15 minutes)

a) What are the key literature sources, especially syntheses, current studies, key people that describe the infrastructure system and the effects on social and ecological systems?

b) Are there key literature sources that describe the effects of climate change to the infrastructure system?

c) List any particularly relevant case studies? (citations or sections in larger syntheses)

d) Are there important historical references for understanding how our knowledge has evolved?

Description of the infrastructure system, drivers and effects of Change (30 minutes)

e) Draw the infrastructure system and its interactions with climate and the local social-ecological system. Show key components, linkages and feedbacks.
f) How are climate-driven factors affecting the infrastructure system? Examples?
g) How is the infrastructure system itself driving social or ecological change? Examples?
h) Are climate and infrastructure interacting in ways that increase impacts on social or ecological systems? Examples?

Vulnerability and resilience (30 minutes)

i) Where are social and ecological systems most vulnerable to the infrastructure/ climate changes?
j) Where have social or ecological systems shown resilience to the effects of climate change, infrastructure growth, or climate-infrastructure interactions?
k) Where might we expect thresholds or sudden transitions leading to regime changes in social-ecological systems resulting from interactions between infrastructure and climate change?
l) How does the location of the infrastructure system affect its response to climate or its effects on social-ecological systems? (In other words, are there examples of where systems have responded differently to the same drivers due to biophysical, geographic, or cultural differences (different soils, climate, topography, geology, culture or regulatory environment)?

Key science questions (20 minutes)

m) What are the most interesting, cutting-edge, critical science questions we still need to answer to understand the climate-infrastructure interactions and the cumulative effects related to this system?

Policy issues (20 minutes)

n) Are there policy or regulatory issues that need to be addressed before we can sustainably manage this infrastructure in a changing Arctic environment?
o) How do we more effectively involve local communities, government, and industry in this conversation?
p) Are their examples of successful adaptation or adaptive management of changes?
q) What gets in the way of successful adaptation or adaptive management of change?

Tools, approaches and institutions (20 minutes)

r) Are there examples of promising strategies for adapting to climate change in this system that might make good case studies?
s) What scientific tools or approaches would be useful for monitoring change in this system?

t) What groups or institutions are already heavily involved in studying climate impacts and adaptation in this infrastructure system? (may be national or international)

u) Are there other groups who might support or collaborate on this work?

v) Which IASC working groups should be involved in efforts to monitor change or address sustainable development in this infrastructure system?

Group presentation (30 minutes for preparation)

A PowerPoint template will be provided to present each group's major findings. Please consolidate the results from you discussions on these templates.

Plan for publication and strategy document

Only limited time was left for this discussion, but the plans for publication and strategy document included:

- Use the RATIC white paper as a foundation, focusing on the major conclusions and recommendations.
- Summarize the results from the breakout groups in a table.
- Identify science questions and policy issues that were common to all types of infrastructure and those that were unique to one or two types
- Develop a strategy for addressing the questions and issues based on the tools, approaches and institutions identified by each breakout group.
- "Corridors" and "nodes" emerged as an organizing framework for developing research themes to address various types of infrastructure.

Prague Sustainable Infrastructure Scientific Research Agenda

Whereas:

- Northern ecosystems and communities are strongly impacted by the cumulative effects of rapidly expanding infrastructure and climate change;
- The drivers and effects of infrastructure development, the interactions with climate, and the local social-ecological system are not adequately addressed by the Arctic research community;
- Greater knowledge and coordination are needed to develop and share approaches for adaptively managing infrastructure in a structured, systematic, iterative process that incorporates learning from the outcomes of previous decisions;
- As a consequence, there is an urgent need to implement a multidisciplinary, integrated collaborative system approach to address these issues;

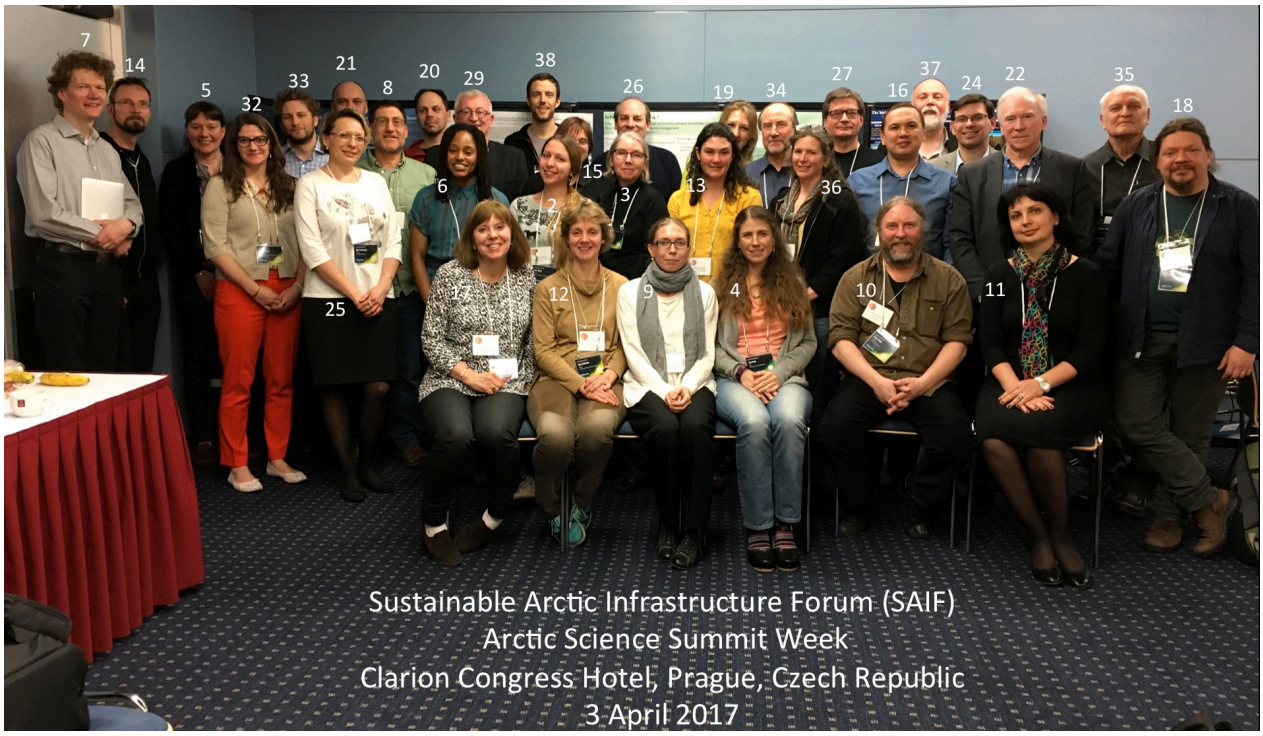
Therefore, the participants assembled at the Sustainable Arctic Infrastructure Forum (SAIF) at Arctic Science Summit Week 2017 resolve to accomplish the following in the next 5 years***:***

- Promote the topic of **sustainable infrastructure development** as a key research theme of the next five-years of international Arctic research,
- Involve scientists, local communities, governments, industry and the general public inside and outside the Arctic in this research,

- Publish a synthesis of sustainable Arctic infrastructure research findings in peer-reviewed scientific journals and more publicly accessible platforms,
- Pursue funding to continue the Rapid Arctic Transitions due to Infrastructure and Climate (RATIC) initiative, included in ICARP III, as a forum for developing and sharing new ideas and methods to facilitate the best practices for assessing, responding to, and adaptively managing the cumulative effects of Arctic infrastructure and climate change,
- Develop a strategic plan to accomplish these goals by December 2017.

-Signed by the SAIF participants, Prague, April 3 2017

Appendix A. Participant List



First Name	Last Name	Affiliation	Country	Email
1. Annett	Bartsch *	Central Institute for Meteorology & Geodynamics, Vienna	Austria	Annett.Bartsch@zamg.ac.at
2. Anna	Bobrik	Lomonosov Moscow State University	Russia	ann-bobrik@yandex.ru
3. Leah	Braithwaite	ArcticNet, Université Laval, Québec	Canada	leah.braithwaite@arcticnet.ulaval.ca
4. Amy	Breen	University of Alaska Fairbanks	USA	albreen@alaska.edu
5. Hanne	Christiansen	The University Centre in Svalbard (UNIS)	Norway	hanne.christiansen@unis.no
6. Tracie	Curry	University of Alaska Fairbanks	USA	tncurry3@alaska.edu
7. Hajo	Eicken	University of Alaska Fairbanks	USA	heicken@alaska.edu
8. Howard	Epstein	University of Virginia, Charlottesville	USA	hee2b@eservices.virginia.edu
9. Ksusha	Ermokhina	Earth Cryosphere Institute, Moscow	Russia	diankina@gmail.com
10. Bruce	Forbes	Arctic Centre, Rovaniemi	Finland	bruce.forbes@ulapland.fi
11. Violetta	Gassly	Kuban State University, Krasnodar	Russia	vgassly@mail.ru
12. Olga	Goncharova	Lomonosov Moscow State University	Russia	goncholgaj@gmail.com
13. Shawnee	Gowan	University of Alaska Fairbanks	USA	sagowan@alaska.edu
14. J. Otto	Habeck	University of Hamburg	Germany	fknv206@uni-hamburg.de
15. Birgit	Heim	Alfred Wegener Institute, Potsdam	Germany	Birgit.Heim@awi.de

16. Nikita	Kaplin	Association of Numerically Small People of the North, Evenki Municipal Area	Russia	
17. Olga	Khitun	Komarov Botanical Institute, St. Peterburg	Russia	khitun-olga@yandex.ru
18. Timo	Kumpula	University of Eastern Finland, Joensuu	Finland	timo.kumpula@uef.fi
19. Elena	Kuznetsova	Norwegian University of Science and Technology, Trondheim	Norway	elena.kuznetsova@ntnu.no
20. George	Matyshak	Lomonosov Moscow State University	Russia	matyshak@gmail.com
21. Pavel	Orekhov	Earth Cryosphere Institute, Moscow	Russia	orekhov.eci@gmail.com
22. Vladimir	Pavlenko	Russian Academy of Science, IASC Council	Russia	pavlenko@presidium.ras.ru
23. Jana	Peirce*	University of Alaska Fairbanks	USA	jlpeirce@alaska.edu
24. Andrey	Petrov	University of Northern Iowa, Cedar Falls	USA	andrey.petrov@uni.edu
25. Olga	Povoroznyuk	University of Vienna	Austria	olga.povoroznyuk@univie.ac.at
26. Bob	Rich	Arctic Research Consortium of the U.S. (ARCUS), Fairbanks	USA	rhrich1@gmail.com
27. Vladimir	Romanovsky	University of Alaska Fairbanks	USA	veromanovsky@alaska.edu
28. Gertrude	Saxinger*	University of Vienna	Austria	gertrude.saxinger@univie.ac.at
29. Peter	Schweitzer	University of Vienna	Austria	peter.schweitzer@univie.ac.at
30. Nikolai	Shiklomanov *	George Washington University, Washington, D.C.	USA	shiklom@gwu.edu
31. Dmitri	Streletskiy *	George Washington University, Washington, D.C.	USA	strelets@gwu.edu
32. Michelle	Slaney	Memorial University of Newfoundland	Canada	slaney@mun.ca
33. Will	Tyson	University of Victoria, B.C.	Canada	wktyson@gmail.com
34. Warwick	Vincent	Université Laval, Center for Northern Studies, Québec	Canada	Warwick.Vincent@fsg.ulaval.ca
35. Skip	Walker	University of Alaska Fairbanks	USA	dawalker@alaska.edu
36. Allison	Woodward	University of Alaska Fairbanks	USA	allison.woodward@alaska.edu
37. Philip	Wookey	Heriot Watt University, Edinburgh	Scotland	P.A.Wookey@hw.ac.uk
38. Scott	Zolkos	University of Alberta, Edmonton	Canada	zolkos@ualberta.ca
39. Gary	Kofinas*	University of Alaska Fairbanks (Talk presented via recorded message)	USA	gkofinas@alaska.edu

* Not in photo

Appendix B: Abstracts of Talks

RATIC and goals of the workshop

The SAIF Workshop is an outgrowth of the Rapid Arctic Transitions due to Infrastructure and Climate (RATIC) initiative that was developed at the ICARP III meeting in Toyama, Japan. One of the overarching messages in the Toyama Conference Statement was: **There is a strong need now to develop a research strategy for sustainable infrastructure development.**

A year later at ASSW 2016 in Fairbanks, Alaska, a RATIC white paper was presented that recommended developing an IASC cross-cutting infrastructure action group to address the issue of cumulative effects of infrastructure and climate change and to actively engage the IASC early career scientists in these activities. The IASC Secretariat providing funds to help organize this workshop.

While RATIC was almost exclusively focused on industrial infrastructure, SAIF recognizes that Arctic infrastructures come in different forms and sizes, from oil and gas development to roads and other transportation infrastructure to water and sewage systems in rural communities. Certain forms of physical infrastructure are a precondition for contemporary life in the Arctic, while others do not seem to benefit local residents. Thus, the question about sustainable infrastructure development and maintenance is also a question about choices and their associated costs and benefits.

Today's SAIF workshop will address ICARP III Research Priority 3: To "*understand the vulnerability and resilience of Arctic environments and societies to the cumulative effects and interactions between infrastructure and climate change*." The goals of the workshop are to identify priority infrastructure-related issues within the sphere of each IASC working group and develop a coordinated action plan for Sustainable Arctic Infrastructure that will address as many issues as possible. A final goal is to leave today with the broad outline of a journal paper on Rapid Arctic Transitions due to Infrastructure and Climate Change that captures and furthers the discussion.

Skip Walker, University of Alaska Fairbanks,USA

Ecological effects of infrastructure and its impacts on reindeer herding

In central Yamal peninsula, which is a permafrost area, both natural and anthropogenic changes have occurred during the past 40 years. The hydrocarbon industry is presently the source of most ecological change in the Yamal peninsula and the socio-economic impacts experienced by migratory Nenets herders who move annually between winter pastures at treeline and the coastal summer pastures by the Kara Sea. The mega-size Bovanenkovo Gas Field (BGF) was discovered in 1972, and large-scale infrastructure began to be built in the mid-1980s. The gas field was finally began production in October 2012.

Employing a variety of high- to very high-resolution aerial photographs and satellite-based sensors (Corona, KH-9, Landsat, SPOT, Quickbird-2, Worldview-2, MODIS), we have followed the establishment and spread of Bovanenkovo. Extensive onsite field observations and measurements of land-use and land-cover changes since 1985 have been combined with intensive participant observation in all seasons among indigenous Nenets reindeer herders and long-term gas-field workers during 2004–2007 and 2010–

2014. Another focus of the study has been cryogenic landslides. Reindeer tend to use fresh barren landslides as an area of insect relief and after a few years landslides began to grow grasses that reindeer graze. Later landslides are occupied by willows (*Salix*), e.g. increased shrub growth.

Nenets managing collective and privately owned herds of reindeer have proven adept in responding to a broad range of intensifying industrial impacts at the same time as they have been dealing with symptoms of a warming climate and thawing permafrost phenomena. Here we detail both the spatial extent of gas-field growth, landslides, drying lakes, shrub increase and the dynamic relationship between Nenets nomads and their rapidly evolving social-ecological system.

Timo Kumpula[1], Anna Skarin, Marc Macias-Fauria, Bruce C. Forbes
[1] University of Eastern Finland, Joensuu, Finland

Social effects of infrastructure

While there is a long history of studying the social impacts of development projects, the social effects of infrastructure in the narrow sense – that is the material and organizational foundations of development – are rarely investigated. The presentation will address some of the known effects of development and its infrastructure, without focusing on the technicalities of social impact assessments. It will conclude with a summary of research needs regarding human-infrastructure interactions.

Peter Schweitzer, University of Vienna, Austrian Polar Research Institute

Adaptive management and cumulative effects

Cumulative effects are the consequence of multiple interacting drivers of change resulting in outcomes that are greater than the additive effects of individual activities. *Adaptive management* (and adaptive governance) are decision making processes that enhance social learning to help avoid unanticipated consequences and build resilience in social-ecological systems. I outline these concepts and explore ways they may be applied in the context of the systems breakout groups will be discussing later in our workshop.

Gary Kofinas, University of Alaska Fairbanks, USA

Keynote Student Presentation:

Cumulative effects of environmental change on culturally significant ecosystems in the Inuvialuit settlement region

The Inuvialuit Settlement Region (ISR), in the western Canadian Arctic, is experiencing environmental change that impacts subsistence harvesting practices and is of concern to local communities (Berkes & Jolly 2001; Pearce et al. 2010; Bennett & Lantz 2014). These impacts are often described qualitatively, but there have been few broad-scale, quantitative assessments of cumulative effects on cultural land use in the region.

In order to create a tractable measure of the impact of multiple disturbances on wildlife harvesting areas in the ISR, we created a cumulative disturbance map that displays relative intensity of terrestrial disturbances across the study region and assessed their overlap with wildlife harvesting areas and important management zones. Subsequently,

we modeled nine future disturbance scenarios that included combinations of increased human impacts and higher occurrences of wildfire. Using the conservation planning software, Marxan (Ball et al. 2009), we measured impact of changing disturbance levels on the potential to conserve un-impacted harvesting lands.

Results show that environmental disturbance already impacts important management zones, wildlife-harvesting areas. Marxan optimizations show that existing disturbance levels create thresholds for conservation of wildlife harvesting areas and future disturbances will further limit conservation potential. This suggests that land-use planning must account for future disturbances in order to maintain large, undisturbed wildlife harvesting areas.

William Tyson, University of Victoria, Canada