Cover

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Project Title:	Cumulative Effects of Arctic Oil Development - planning and designing for sustainability
PD/PI Name:	Donald A Walker, Principal Investigator Gary P Kofinas, Co-Principal Investigator Yuri L Shur, Co-Principal Investigator
Recipient Organization:	University of Alaska Fairbanks Campus
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Submitting Official (if other than PD\PI):	Donald A Walker Principal Investigator
Submission Date:	08/29/2020
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Donald A Walker

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Accomplishments

*** What are the major goals of the project?**

Cumulative Effects of Arctic Oil Development -- Planning and Designing for Sustainability

Developing Arctic oil & gas resources requires extensive networks of roads, pipelines and other forms of infrastructure. The cumulative environmental and social effects of expanding developments are difficult to assess — especially in the face of rapid climate change and unpredictable politics, oil markets, and social and economic changes. Previous analyses of the cumulative effects (CE) of oil and gas development in northern Alaska have recommended comprehensive adaptive planning approaches to 1) minimize the spread of infrastructure across land that is used by indigenous people for subsistence, and 2) reduce the indirect effects of infrastructure that result in the thawing of ice-rich permafrost. A sustainable approach to CE requires collaboration between indigenous people, industry, and scientists from a broad spectrum of disciplines to address these infrastructure-related concerns. This project had four inter-related goals:

Goals with high intellectual merit:

1. Hierarchical case study of the cumulative effects of industrial infrastructure at Prudhoe Bay, Alaska. This goal focuses on the combined infrastructure-related effects associated with gravel mines, roads and other areas of gravel placement, and climate-related changes to ecosystems. The study is developing a process-based understanding of infrastructure-related permafrost, landform, and vegetation change in terrain undergoing thermokarst formation (the development of highly eroded landforms that result from the thawing of ice-rich permafrost). The project includes an examination of infrastructure and landscape change at multiple scales in the Prudhoe Bay Oilfield (PBO) and field studies of change along roads. The study will help to answer the questions “What will these areas look like in 50-100 years?” and “Can adaptive management methods address the complex issues related to placement, usage and decommissioning of infrastructure in Northern Alaska?”

2. Social-ecological implications and adaptive management of climate change and thawing permafrost. As the Arctic’s ecosystems and infrastructure networks change, so do its peoples. Most residents of the Arctic make their homes in small to medium sized communities, often in remote regions where they rely heavily on climate-sensitive livelihoods. This research was undertaken to explore the current and potential influences of thawing permafrost and other climate changes on important aspects of community life in two Iñupiaq villages of Alaska’s Arctic, Anaktuvuk Pass and Selawik.

Goals with mainly broader impacts:

3. An international Arctic Infrastructure action group: Rapid Arctic Transitions due to Infrastructure and Climate (RATIC). The goal of RATIC is to bring cumulative-effects-of-infrastructure issues to greater prominence within the international Arctic research community and encourage research on the joint effects of climate change and expanding infrastructure in the Arctic.

4. Education/outreach component. A new field course is training students in arctic system science and introducing them to the issues of industrial development and adaptive management approaches. The 21-day course includes a 16-day expedition along the Elliott and Dalton highways in Alaska. The course includes a visit to Minto, an Athabascan village on the Tolovana River; Wiseman, an old mining community along the Dalton Highway; and the Prudhoe Bay Oilfield, where they learn firsthand about the issues with oilfield infrastructure, its impacts and the oil industry's ecological monitoring and vegetation rehabilitation practices.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: Major activities during Sep 2019-Aug 2020 included:

1. Continued monitoring of the road effects sites at Prudhoe Bay, AK during 2020 field season, Aug 12-21.

2. Continued development of Infrastructure Action Group as part of theT-MOSAiC initiative: https://www.tmosaic.com/infrastructure.html

3. Continued progress on Woodward Ph.D. thesis

4. Continued work to convert our data management system (Alaska Arctic Geoecological Atlas, AAGA (https://arcticatlas.geobotany.org) from the current content management system called gLynx to CKAN (Comprehensive Kerbal Archive Network). This is an emergency unanticipated cost that was needed because the Geographic Information Network of Alaska (GINA, UAF), which currently houses the AAGA, will no longer support gLynx. CKAN is widely a used open-source cataloging system, and the conversion to CKAN will make the data catalog and user interface more stable and more portable for long-term security of the data. This will require 2 months of support for two programmers, project management and computer support (Cost: estimated $70K).

5. Published 1 journal publications (Raynolds et al. 2020) and 1 M.S. thesis (Kasanke 2019).

6. Continued work to 2 synthesis papers regarding permafrost and vegetation impacts of a road in ice-wedge polygons (Kanevskiy et al. 2020 in prep. and Walker et al. 2020 in prep.)

Specific Objectives: The orignial goals and objectives of the project were modified and expanded somewhat to include the following components:

I. Components with high intellectual merit:

Component 1. Hierarchical case study of the cumulative effects of industrial infrastructure at Prudhoe Bay, Alaska.

Component 1a. Herarchical map-based GIS analysis of long-term (1949–2010) change in the Prudhoe Bay Oilfield (PBO). This component focused on infrastructure-related effects associated with gravel mines, roads and other areas of gravel placement at two scales: (1) the entire PBO, and (2) three highly impacted 22 km2 areas, where both changes to infrastructure and the landscapes (vegetation, landforms, surficial landforms) were measured.

Component 1b. Remote sensing analysis of recent (1985–2011) regional environmental change as depicted by Landsat-derived NDVI measurements. This component examined regional changes of the Normalized Difference Vegetation Index

(NDVI), an index of vegetation greenness and biomass, using Landsat TM and ETM+ data. The study was conducted in the central Alaska North Slope region, which includles the PBO, and where the vegetation and landscapes are relatively well-known and mapped. We calculated trends in the normalized difference vegetation index (NDVI) and tasseled-cap transformation indices, and related them to high-resolution aerial photographs, ground studies, and vegetation maps.

Component 1c. Ground-based plot-level studies of infrastructure- and climate-related change. Most Arctic roads and infrastructure are built on thick gravel to protect the permafrost. How are these roads interacting with climate change to affect the underlying permafrost and ice-wedge polygon landscapes? We use historical aerial photographs (1949–2013) and ground-based studies to examine a heavily traveled road in the Prudhoe Bay Oilfield (PBO), Alaska.Two intensive study sites were established within the heavily-impacted Deadhorse area of the PBO region. The study is developing a process-based understanding of infrastructure-related permafrost/ landform/ vegetation succession in roadside areas undergoing both climate and infrastructure-related changes.

Component 1d. Analysis of winter impacts of 3D seisimic activities. Although three-dimensional (3D) seismic surveys have improved the success rate of exploratory drilling for oil and gas, the impacts have received little scientific scrutiny, despite affecting more area than any other oil and gas activity. To aid policy-makers and scientists, we reviewed studies of the landscape impacts of 3D-seismic surveys in the Arctic. We analyzed a proposed 3D-seismic program in northeast Alaska, in the northern Arctic National Wildlife Refuge, which includes a grid of approximately 63,000 km of seismic trails and additional camp-move trails.

Component 2. Social-ecological implication and adaptive management of climate change and thawing permafrost in two Iñupiaq communites of Arctic Alaska. This research was undertaken to explore the current and potential influences of thawing permafrost and other climate changes on important aspects of community life in two Iñupiaq villages of Alaska's Arctic, Anaktuvuk Pass and Selawik. The study also examined the villages' adaptive approches to managing the changes.

II. Components with mainly broader impacts:

Component 3. International Arctic infrastructure action group: Rapid Arctic Transitions due to Infrastructure and Climate (RATIC). The goal of RATIC is to bring cumulative-effects-of-infrastructure issues to greater prominence within the international Arctic research community and encourage research on the joint effects of climate change and expanding infrastructure in the Arctic.

Component 4. Education/ outreach. A new field course is training students in arctic system science and introducing them to the issues of industrial development and adaptive management approaches. The 21-day course includes a 16-day expedition along the Elliott and Dalton highways in Alaska. The course includes a visit to Minto, an Athabascan village on the Tolovana River; Wiseman, an old mining community along the Dalton Highway; and the Prudhoe Bay Oilfield, where they learn firsthand about the issues with oilfield infrastructure, its impacts and the oil industry's ecological monitoring and vegetation rehabilitation practices.

Significant Results:

Key publications and conclusions for components with hight intellectual merit (Components 1 and 2):

Component 1a. Herarchical map-based GIS analysis of long-term (1949–2010) change in the Prudhoe Bay Oilfield (PBO).

Key publications:

Raynolds, M.K. et al., 2014. Cumulative geoecological effects of 62 years of infrastructure and climate change in ice-rich permafrost landscapes, Prudhoe Bay Oilfield, Alaska. *Global Change Biology*, 20(4), pp.1211–1224.

Walker, D.A. et al. eds., 2014. *Landscape and permafrost change in the Prudhoe Bay Oilfield, Alaska*, Fairbanks, AK: Alaska Geobotany Center, University of Alaska, AGC Publication 14-01. Available at: http://www.geobotany.uaf.edu/library/pubs/WalkerDA2014_agc14-01.pdf.

Key conclusions:

1. Thermokarst has recently affected broad areas of the entire region, and that a sudden increase in the area affected by thermokarst began shortly after 1990 corresponding to a rapid rise in regional summer air temperatures and related permafrost temperatures.

2. A conceptual model that describes how infrastructure-related factors, including road dust and roadside flooding are contributing to more extensive thermokarst in areas adjacent to roads and gravel pads.

3. By 2010, over 34% of the intensively mapped area was affected by oil development. In addition, between 1990 and 2001, coincident with strong atmospheric warming during the 1990s, 19% of the remaining natural landscapes (excluding areas covered by infrastructure, lakes and river floodplains) exhibited expansion of thermokarst features resulting in more abundant small ponds, greater microrelief, more active lakeshore erosion and increased landscape and habitat heterogeneity. This transition to a new geoecological regime has major implicationss to wildlife habitat, local residents and industry.

Component 1b. Remote sensing analysis of recent (1985–2011) regional environmental change as depicted by Landsat-derived NDVI measurements.

Key Publication:

Raynolds, M.K. & Walker, D.A., 2016. Increased wetness confounds Landsat-derived NDVI trends in the central Alaska North Slope region, 1985–2011. *Environmental Research Letters*, 11(8), p.085004.

Key conclusions:

1. Significant, mostly negative, changes in NDVI occurred in 7.3% of the area, with greater change in aquatc and barren types. Large reflectance changes due to erosion, deposition and lake drainage were evident.

2. Regional trends showed decreases in NDVI for most vegetation types, but increases in tasseled-cap greenness (56% of study area, greatest for vegetation types with high shrub cover) and tasseled-cap wetness (11% of area), consistent with documented degradation of polygon ice wedges, indicating that increasing cover of water may be masking increases in vegetation when summarized using the water-sensitive NDVI.

Component 1c. Ground-based plot-level studies of infrastructure- and climate-related change.

Key data reports and publications:

Kanevskiy, M. et al., 2020 (in prep). Cryostratigraphy of the upper permafrost and risk of ice-wedge thermokarst in relation to road infrastructure, Prudhoe Bay oilfield, Alaska. *Arctic Science*.

Walker, D.A. et al., 2015. *Infrastructure-Thermokarst-Soil-Vegetation Interactions at Lake Colleen Site A, Prudhoe Bay, Alaska*, Fairbanks. Available at:

https://www.geobotany.uaf.edu/library/pubs/WalkerDA2015_agc15-01_datarpt.pdf.

Walker, D.A. et al., 2016. *Airport study site, Prudhoe Bay, Alaska, Summer 2015: Road effects data report*, Fairbanks, AK: Alaska Geobotany Center. Available at: https://www.geobotany.uaf.edu/library/pubs/WalkerDA2016_agc16-01_datarpt.pdf.

Walker, D.A. et al., 2020 (in prep.). Long-term vegetation and environmental effects of a road in an ice-wedge polygon landscape, Prudhoe Bay Oilfield, Alaska. *Arctic Science*.

Key conclusions:

1. The extent of thermokarst ponds and water-filled polygon troughs changed little between 1949 and 1989, increased near the road after 1989, and both near and distant from the road after 2000. Most of the original dominant low-center polygons changed to a mix of transitional and high-center with 0.5 m to >1.0 m of relief.

2. Roadside flooding caused deeper subsidence above ice wedges, greater polygon relief, deeper active layer thickness, taller vegetation, and higher leaf area indices. Flooding, snow drifts, earlier snow melt, and dust on both sides of the road cause deeper active layers and enhanced thermokarst.

3. Heavy road dust reduced vegetation diversity, especially of mosses and lichens. It is likely that all low-centered polygon within 200 m of roads in the PBO have altered topography, increased thermokarst, and reduced plant diversity.

4. Ice-wedge degradation is controlled by numerous interacting factors such as climate, topography, vegetation, surface and groundwater, and soil properties, which create positive and negative feedbacks.

5. The processes of ice-wedge degradation and stabilization are regulated by structure, properties, and thicknesses of soil layers above ice wedges, which include the active, transient, and intermediate layers. Occurrence of the intermediate layer indicates permafrost aggradation above ice wedges, which provides their long-term stability. Stabilized ice wedges have thicker intermediate layer on top of them and, therefore, better protection from thermokarst than undegraded wedges.

6. In the areas of cold continuous permafrost, stabilization and recovery of ice wedges actively degrading beneath deep thermokarst ponds commonly start under the water as a result of accumulation of organic matter and mineral soils. Numerous deep old ponds have been relatively stable for many decades due to formation of the ice-rich intermediate layer above partially degraded ice wedges.

7. Despite a strong influence of the infrastructure on the active layer and the upper permafrost stability through changes in hydrology and surface conditions, ice-wedge degradation in the study areas is a reversible process and ice wedges near the roads are becoming stabilized.

Component 1d. Analysis of winter impacts of 3D seisimic activities.

Key Publication:

Raynolds, M.K. et al., 2020. Landscape impacts of 3D-seismic surveys in the Arctic National Wildlife Refuge, Alaska. *Ecological Applications*, 35, p.203.

Key conclusions:

1. Approximately 122 km2 of the Arctic National Wildlife Refuge would likely sustain direct medium- to high-level disturbance from the proposed exploration, with possibly expanded impacts through permafrost degradation and hydrological connectivity.

2. Strong winds are common, and snow cover necessary to minimize impacts from vehicles is windblown and inadequate to protect much of the area.

3.The permafrost is ice rich, which combined with the hilly topography, makes it especially susceptible to thermokarst and erosion triggered by winter vehicle traffic.

4.The effects of climate warming will exacerbate the impacts of winter travel due to warmer permafrost and a shift of precipitation from snow to rain.

5. Current regulations are not adequate to eliminate impacts from 3D-seismic activities. The cumulative impacts of 3D-seismic traffic in tundra areas need to be better assessed, together with the effects of climate change and the industrial development that would likely follow.

6. Current data needs include studies of the impacts of 3D-seismic exploration, better climate records for the Arctic National Wildlife Refuge, especially for wind and snow; and high-resolution maps of topography, ground ice, hydrology, and vegetation.

Component 2. Social-ecological implication and adaptive management of climate change and thawing permafrost in two Iñupiaq communites of Arctic Alaska.

Key Publication:

Woodward, A. 2020 (in prep.) Social-ecological implications of climate change and thawing permafrost in two Iñupiaq communities of Arctic Alaska. Ph.D. Thesis, University of Alaska Fairbanks.

Key conclusions:

In development. Thesis to be conpleted Spring Semester 2021.

Key outcomes or Other achievements:

The broader impacts are addressed in Components 3 and 4:

Component 3. International Arctic infrastructure action group: Rapid Arctic Transitions due to Infrastructure and Climate (RATIC). In 2020, RATIC assumed the role of the T-MOSAiC Infrastructure Action Group during the 2019–2021 MOSAiC Arctic Drift Expedition. Dr. Walker and Peter Schweitzer (U. of Vienna) are co-chairs of the AG, and Jana Peirce is the Coordinator. The action group will collaborate with T-MOSAiC to identify and promote activities and synergies that lead toward sustainable Arctic infrastructure, including those that:

- Monitor the consequences to natural terrestrial systems of unusual climate sea-ice, atmosphere, and ocean changes during the MOSAiC ice-drift expedition.
- Observe and monitor consequences to the built environment, including, roads, runways, railways, pipelines, and indigenous, village, and urban infrastructure.
- Examine the consequences of climate and infrastructure changes to Arctic social systems.
- Begin developing an Arctic infrastructure observing network, with a focus on coastal and near-coastal social-ecological systems in ice-rich-permafrost environments.

RATIC was born with the goal of promoting sustainable Arctic infrastructure as a key research theme requiring a collaborative multidisciplinary approach involving scientists, local communities, governments and industry.

Component 4. Education/ outreach. A new field course is training students in arctic system science and introducing them to the issues of industrial development and adaptive management approaches. The 21-day course includes a 16-day expedition along the Elliott and Dalton highways in Alaska. The course includes a visit to Minto, an Athabascan village on the Tolovana River; Wiseman, an old mining community along the Dalton Highway; and the Prudhoe Bay Oilfield, where they learn firsthand about the issues with oilfield infrastructure, its impacts and the oil industry's ecological monitoring and vegetation rehabilitation practices. This field course was conducted in 2014, 2015, 2016, and 2018. It was cancelled in 2020 due to the COVID situation in Alaska, which prevented foreign students entering Alaska and greatly reduced travel on the Dalton Highway.

*** What opportunities for training and professional development has the project provided?**

The project has helped support 1 post doc (Marcel Buchhorn), 2 Ph.D. graduate students (Tracie Curry and Allison Woodward), 2 Masters graduate students (Shawnee Kasanke and Emily Watson-Cook) and a total of 33 graduate and undergraduate students who have taken the summer course BIOL 495/695, (Alaska Arctic Geobotany, and Arctic Alaska Vegetation, Field Excursion to the Brooks Range and Beyond).

*** How have the results been disseminated to communities of interest? If so, please provide details.**

The results have been disseminated in key publications and data reports listed above for each conponent. The publications are listed on the project's web site: https://www.geobotany.uaf.edu/arcsees/.

Considerable effort is also devoted to communication with the international community through the RATIC project: https://www.geobotany.uaf.edu/ratic/

and the T-MOSAiC Infrastructure Action Group: https://www.t-mosaic.com/infrastructure.html

*** What do you plan to do during the next reporting period to accomplish the goals?**

We have received a no-cost extension to:

1. Complete the publications currently in preparation.

2. Provide support for Allison Woodward to complete her Ph. D. thesis

3. To finish development of our Alaska Arctic Geobotanical Atlas map and plot data archives, which have been essential for completion of Components 1a, 1b, and 1c.

Products

Books

Book Chapters

Inventions

Journals or Juried Conference Papers

Blair, B and G Kofinas (2018). A comparison of risk perceptions between levels of government in Arctic Alaska underscores the importance of scale in problem definition for adaptation decisions. *Frontiers in Ecology and the Environment – Frontiers in Ecology and the Environment – Special Issue "Social-Ecological Dynamics at the Extreme: Arctic Alaska"*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Brinkman, T, Kofinas, G. et al. (2018). Community research fatigue: A search for solutions. *Frontiers in Ecology and the Environment – Special Issue "Social-Ecological Dynamics at the Extreme: Arctic Alaska"*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Kofinas, G and J. Schmidt (2018). The Art and Science of Assessing Resilience of Arctic Alaska. *Frontiers in Ecology and the Environment – Special Issue "Social-Ecological Dynamics at the Extreme: Arctic Alaska"*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Raynolds, M.K. D.A. Walker, Andrew Balser, Christian Bay, Mitch Campbell, Mikhail M. Cherosov, Fred J.A. Daniëls, Pernille Bronken Eidesen, Ksenia A. Ermokhina, Gerald V. Frost, Birgit Jedrzejek, M. Torre Jorgenson, Blair E. Kennedy, Sergei S. Kholod, Igor A. Lavrinenko, Olga V. Lavrinenko, Borgþór Magnússon, Nadezhda V. Matveyeva, Sigmar Metúsalemsson, Lennart Nilsen, Ian Olthof, Igor N. Pospelov, Elena B. Pospelova, Darren Pouliot, Vladimir Razzhivin, Gabriela Schaepman-Strub, Jozef Šibík, Mikhail Yu. Telyatnikov, Elena Troeva (2019). A raster version of the Circumpolar Arctic Vegetation Map

(CAVM). *Remote sensing of environment*. 232 1111297. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: https://doi.org/10.1016/j.rse.2019.111297

Raynolds, M.K., Jorgenson, J.C., Jorgenson, M.T., Kanevskiy, M., Liljedahl, A.K., Nolan, M., Sturm, M., Walker, D.A. (2020). Landscape impacts of 3D-seismic surveys in the Arctic National Wildlife Refuge, Alaska. *Ecological Applications*. 35 203. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: https://doi.org/10.1002/eap.2143

Schmidt, J and G Kofinas (). Local knowledge and western science in a rapidly changing socio-ecological system. *Frontiers in Ecology and the Environment – Special Issue “Social-Ecological Dynamics at the Extreme: Arctic Alaska”*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Schmidt, J, G Kofinas, N. O’Neal, T. Brinkman (2019). Local Knowledge and Science: Observations of Landscape Change in the Nuiqsut Homelands. *Special Report published by the University of Alaska Fairbanks – A report of the Alaska EPSCoR Project*. 1-24. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = No

Schneider von Deimling, H. Lee, H, T. Ingeman-Nielsen, S. Westermann, V. Romanovsky, S. Lamoureaux, D.A. Walker, S. Chadburn, L. Cai, E. Trochim, J. Nitzbon, S Jacobi, M. Langer. (2020). Consequences of permafrost degradation for Arctic infrastructure - bridging the model gap between regional and engineering scales. *The Cryosphere*. . Status = ACCEPTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Licenses

Other Conference Presentations / Papers

Other Products

Other Publications

Patent Applications

Technologies or Techniques

Thesis/Dissertations

Kasanke, S. A.. *Plant succession in the arctic Brooks Range: floristic patterns from alpine to foothills, along a glacial chronosequence and elevation gradient*. (2019). University of Alaska Fairbanks. Acknowledgement of Federal Support = Yes

Websites or Other Internet Sites

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Walker, Donald	PD/PI	4
Kofinas, Gary	Co PD/PI	1
Shur, Yuri	Co PD/PI	1
Buchhorn, Marcel	Postdoctoral (scholar, fellow or other postdoctoral position)	0
Raynolds, Martha	Postdoctoral (scholar, fellow or other postdoctoral position)	2

Name	Most Senior Project Role	Nearest Person Month Worked
Matyshak, George	Other Professional	0
Peirce, Jana	Other Professional	2
Wirth, Lisa	Other Professional	0
Curry, Tracie	Graduate Student (research assistant)	0
Woodward, Allison	Graduate Student (research assistant)	2

Full details of individuals who have worked on the project:

Donald A Walker
Email: dawalker@alaska.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 4

Contribution to the Project: PI, organized and conducted 2020 field season, wrote synthesis paper,

Funding Support: Partial support from this grant, Mainly UAF

International Collaboration: No
International Travel: No

Gary P Kofinas
Email: gary.kofinas@alaska.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Co PI supervised thesis of Allison Woodward

Funding Support: 1 week this grant

International Collaboration: No
International Travel: No

Yuri L Shur
Email: yshur@alaska.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Co-PI, supervises permafrost research at the Prudhoe Bay research sites

Funding Support: 1 week this grant

International Collaboration: No
International Travel: No

Marcel Buchhorn
Email: mbuchhorn@alaska.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 0

Contribution to the Project: Post-doc, field work, GIS/remote sensing lab manager, building new facility

Funding Support: This project plus NASA LCLUC Grant, and PreABoVE

International Collaboration: Yes, Belgium
International Travel: No

Martha K Raynolds
Email: mkraynolds@alaska.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 2

Contribution to the Project: Field research, mapping, wrote 2 publications

Funding Support: This project

International Collaboration: No
International Travel: No

George Matyshak
Email: matyshak@gmail.com
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 0

Contribution to the Project: Soils descriptions and analysis at field sites

Funding Support: partial support from this grant

International Collaboration: Yes, Russian Federation
International Travel: No

Jana L. Peirce
Email: jlpeirce@alaska.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 2

Contribution to the Project: Coordination of project. Writing and editing reports, field work, data analysis

Funding Support: this grant

International Collaboration: No
International Travel: No

Lisa Wirth
Email: lisa@gina.alaska.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 0

Contribution to the Project: Mapping, GIS, web site, field work

Funding Support: This project, NASA PreABoVE project

International Collaboration: No
International Travel: No

Tracie Curry
Email: tncurry3@alaska.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 0

Contribution to the Project: Ph.D. thesis, completed in 2019

Funding Support: This project

International Collaboration: No
International Travel: No

Allison Woodward
Email: allison.woodward@alaska.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 2

Contribution to the Project: Ph.D. thesis on effects of climate and permafrost change to local communities

Funding Support: Partial support from this project and EPSCoR grant

International Collaboration: No
International Travel: No

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Earth Cryosphere Institute	Other Organizations (foreign or domestic)	Tyumen, Russia
University of Eastern Finland	Academic Institution	Finland

Full details of organizations that have been involved as partners:

Earth Cryosphere Institute

Organization Type: Other Organizations (foreign or domestic)
Organization Location: Tyumen, Russia

Partner's Contribution to the Project:
Financial support
In-Kind Support
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Helping with RATIC workshop and Russian case study

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University of Eastern Finland

Organization Type: Academic Institution
Organization Location: Finland

Partner's Contribution to the Project:
Financial support
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Helping with the RATIC workshop and Russian case study

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What other collaborators or contacts have been involved?
Nothing to report

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The project has had a major impact on the emphasis that is being placed on scientific analysis of cumulative effects of infrastructure and climate change at the national and international level. Where before the ArcSEES project, there was virtually no emphasis on Arctic Infrastructure within NSF, several new programs including Navigating the New Arctic (NNA) have greatly expanded the focus on infrastructure. This is also demonstrated at the international level where our Rapid Arctic Transitions due to Infrastructure and Climate (RATIC) initiative now forms the core of IASC T-MOSAiC Infrastructure Action Group, which is observing and monitoring consequences to the built environment to Arctic social ecological systems and developing an Arctic infrastructure observing network.

What is the impact on other disciplines?

This is perhaps best illustrated by the cross disciplinary activities of the IASC RATIC project, which involves numerous investigators from Terretrial, Social and Human, Cryosphere Working groups and includes permafrost scientists, climatologists, hydrologists, vegetation and soil scientists, ecologists, remote sensing scientiests, and social scientists.

What is the impact on the development of human resources?

The project has helped support 1 post doc (Marcel Buchhorn), 2 Ph.D. graduate students (Tracie Curry and Allison Woodward), 2 Masters graduate students (Shawnee Kasanke and Emily Watson-Cook) and a total of 33 graduate and undergraduate students who have taken the summer course BIOL 495/695, (Alaska Arctic Geobotany, and Arctic Alaska Vegetation, Field Excursion to the Brooks Range and Beyond).

What is the impact on physical resources that form infrastructure?

The project is developing an online Arctic Geobotanical Atlas that is archiving and displaying plot and map data useful in the analysis of impacts of Arctic infrastructure.

What is the impact on institutional resources that form infrastructure?

Nothing to report.

What is the impact on information resources that form infrastructure?

The project is developing an online Arctic Geobotanical Atlas that is archiving and displaying plot and map data useful in the analysis of impacts of Arctic infrastructure.

What is the impact on technology transfer?

Nothing to report.

What is the impact on society beyond science and technology?

The broader impacts are related to involvement and learning from local indigenous communities and industry regarding their perceptions of change due to infrastructure and climate change. This has had major influence on the development of the social dimension of our new NNA project.

Changes/Problems

Changes in approach and reason for change

We requested and received a no-cost extension to complete work on Part 1 of the project: to complete a case study of infrastructure cumulative effects. We have completed nearly all of the analysis associated with the project but still have some remaining writing to do. We will not be able to spend it as budgeted due to difficulty in completing tasks in a timely manner due to COVID issues, and partly to some difficult personal issues of one of the co-PIs, Gary Kofinas, and his Ph.D. student, Allison Woodward. Gary is in the process of dealing with the his partner who has cancer, and Alisaon has had a severe emotional setback following the death of her husband. The funds will be used for: a) completion and submittal of two papers and a PhD thesis, and b) conversion our data management system. This was an emergency unanticipated cost that was needed because the Geographic Information Network of Alaska (GINA, UAF), which houses our Alaska Arctic Geoecological Atlas no longer supported our old DMS. CKAN is a widely used open-source cataloging system, and the conversion to CKAN will make the data catalog and user interface more stable and more portable for long-term security of the data.

Actual or Anticipated problems or delays and actions or plans to resolve them

The NCE was needed because the PI contracted COVID-19 and was able to work only at much reduced pace for 3 months and is was greatly hampered by the University Lockdown. It also affected the work schedules and project communication and adminstration because the general unavailability of staff. This prevented the timely completion of several publications and other activities associated with the project.

Changes that have a significant impact on expenditures

There are approximately $39,000 in unobligated funds (+ $12,000 in F&A) which will be used for salary and benefits to support the graduate student, Allison Woodward, for one semester to complete her Ph.D. and for GINA personnel to complete transferal of map datasets to the new archive. Part of the funds were reprogrammed to support 1 semester of Ph.D. Research Assistantship for Allison Woodward to complete her thesis.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.

Special Requirements

Responses to any special reporting requirements specified in the award terms and conditions, as well as any award specific reporting requirements.