Preview of Award 1263854 - Annual Project Report

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Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1263854
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
Project/Grant Period:	09/15/2013 - 08/31/2018
Reporting Period:	09/01/2014 - 08/31/2015
Submitting Official (if other than PD\PI):	N/A
Submission Date:	N/A
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	N/A

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 and impossible to predict — 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 does that with detailed ground studies, local community input, industry involvement and an international perspective. A project has three major components:

1) A *case study of the cumulative effects of industrial infrastructure at Prudhoe Bay, Alaska* focuses on infrastructure-related effects associated with gravel mines, roads and other areas of gravel placement. The study includes ground-based studies, an examination of infrastructure and landscape change at multiple scales, and a human dimension component that includes evaluation of adaptive management planning for infrastructure in northern Alaska and CE studies associated with the Iñupiat village of Nuiqsut. The study is developing a process-based understanding of infrastructure-related permafrost/ landform/ vegetation succession in terrain undergoing thermokarst formation (the development of highly eroded landforms that result from the thawing of ice-rich permafrost). 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) An *Arctic Infrastructure Action Group: Rapid Arctic Transitions due to Infrastructure and Climate (RATIC)*. This inititaive was developed during the Climate Change 2014 Conference in Ottawa and during the Third Internatiuonal Conference on Arctic Research Planning (ICARP III) in Yohama, Japan. The initiative's goal is to bring cumulative-effects-of-infrastructure issues to greater prominence within the international Arctic research community. RATIC consists of permafrost scientists, ecologists, hydrologists, engineers, social scientists and educators seeking to develop adaptive management strategies that address the unique issues related to networks of infrastructure in arctic permafrost environments.

3) An *education/outreach component* 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:

1. Case study of the cumulative effects of industrial infrastructure at Prudhoe Bay, Alaska: This goal was met with several activities, including:

- A **regional analysis** that is a complete assessment of the historical changes infrastructure for the all the North Slope Oilfield up to 2011. This analysis provides details on extent (numbers, length, area) of all infrastructure features of all the oilfields on the North Slope, from the Canning River to the Colville River.
- A **landscape-level analysis** of three 22-km2 areas where detailed 1:6000-scale GIS databases have been made that include detailed geoecological information (vegetation, landforms, soils, water extent), and historical changes in both direct impacts (roads, pipelines, construction pads, mines and others) and indirect landscape effects (e.g. flooding, dust, thermokarst, trash, off-road vehicle trails, and others).
- A detailed **ground-level investigation** of changes associated with a location of intensive thermokarst along one of the oldest and most heavily traveled roads at Prudhoe Bay, the Spine Road (Lake Colleen Site A).

2. Arctic Infrastructure Action Group, Rapid Arctic Transitions due to Infrastructure and Climate (RATIC). The RATIC initiative is a new forum for developing and sharing new ideas and methods to facilitate the best practices for assessing, reponding to, and adaptively managing the cumulative effects of Arctic infrastructure and climate change. The intiative is being developed through the

International Arctic Science Committee (IASC). Two primary activities this past year included a workshop and papers sessions at the Arctic Change 2014 meeting in Ottawa, Canada, 8-12 December 2014, and the Third International Conference on Arctic Research Planning (ICARP III) meeting at the Arctic Science Summit Week 2015 meeting in Yohama, Japan, 23-30 April 2015. A white paper has been produced that describes five international case studies, conclusions, and recommendations for steps to develop scientific research plans aimed at sustainable infrastructure development.

3. Education/outreach component. This component was addressed with two main activities:

- **Arctic Alaska Enviornmental Change: Field excursion to the North Slope.** The goals for the course are to: (1) Provide students with an in-depth field experience of Arctic environments, local people, current issues and examples of Arctic environmental change, and the oil industry's environmental research program. (2) Provide methods of field sampling of Arctic vegetation, soils, and permafrost in a variety of Arctic ecosystems. (3) Visit Arctic research sites, including Finger Mountain, Atigun Pass, Toolik Lake, Imnavait Creek, Happy Valley, Sagwon, and Prudhoe Bay. The course included visits to the Athabaskan Indian village of Minto, the gold-mining village of Wiseman, the BLM/USPS/USFWS Interagency Visitors Center in Coldfoot, the Toolik Lake Field Station, and the Prudhoe Bay Oilfield. Courses were conducted during 6-21 Jun 2014, and 10-30 Jun 2015 and involved 14 students. The course readings and syllabus are attached.
- **Web site development and publications:** Two new websites are being developed to archive information and provide all project details from the project. One provides general information from the ArcSEES project with information on the projects goals, proposal, annual and other reports, publications, workshops, and key data. The other is a Geoecological Atlas that contains all the map and plot data produced by this project and others that the Arctic Geobotany Center has been involved with during its 45 year history. We have also initiated an AGC publication series that provides web and hard copy data reports from the project.

Specific Objectives:

Significant Results:

Key outcomes or Other achievements:

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

1. 14 students have been trained in Arctic System Science through the the UAF summer field course.

2. A new post-doctoral student, Dr. Marcel Buchhorn, has been recruited to fill our GIS and remote sensing needs, and has become involved with the field research and analysis of the Prudhoe Bay studies.

3. Funds from the ArcSEES project were used to help involve Arctic Polar Early Career Scientists to the RATIC meetings in Canada and Japan during the past year.

4. A young visiting scientist from the Slovak Republic, Dr. Jozef Sibik, and his graduate student, Silvia Chasnikova, are visiting for 5 months to receive training in our methods of data collection and analysis methods, and background in projects including our ArcSEES project.

*** How have the results been disseminated to communities of interest?**

- **Two new websites** are being developed to archive information and provide all project details from the project. One provides general information from the ArcSEES project with information on the projects goals, proposal, annual and other

reports, publications, workshops, and key data (http://www.geobotany.uaf.edu/arcsees/).The other is a Geoecological Atlas is being developed in collaboration with a NASA ABoVE (Arctic and Boreal Vulnerability Experient) project (http://geobotanical.portal.gina.alaska.edu). This site contains all the map and plot data produced by this project and others that the Arctic Geobotany Center has been involved with during its 45-year history.

- **AGC publication series:** We have also initiated an AGC publication series that provides web and hard copy data reports from the project. The publications are listed with the publications. Copies of three of these reports are included in the supporting files.
- **Special Session at the the Arctic Change 2014 meeting in Ottawa, Canada**. The workshop included 40 participants, who presented a variety of case studies from aroung the Arctic. Two topical sessions included 10 oral presentations and 17 posters, with first authors from the U.S. (9 papers, Russian (9 papers), Canada (6 papers), Finland (2 papers), and Norway (1 paper).
- **Public lecture:** A talk entitled "Landscape, permafrost, and social change in the Prudhoe Bay region, Alaska, was given to the Institute of Arctic Biology's seminar series, 23 January 2015.

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

Our main goals this year are:

1. Second field season at Prudhoe Bay to examine road-side thermokarst in an area where the ice-wedge have been completely degraded.
2. Present the RATIC initiative at the Fall 2015 AGU meeting.
3. Publish the results of the field investigations at Colleen Site A.
4. Publish the results of the RATIC workshops.
5. Develop collaborations with other agency and university projects examining infrastructure issues in Alaska and internationally through IARPC and IASC.
6. Conduct a 21-day field course entitled Arctic Alaska Environmental Change in Jun 2016.

Supporting Files

Filename	Description	Uploaded By	Uploaded On
Arctic Alaska Environmental Change 2015 brochure.pdf	Brochure for 2015 Arctic Alaska Environmental Change field course	Donald Walker	07/07/2015
2015_SummerFieldCourse_Syllabus_20150607(orig).5.pdf	Table of contents and syllabus for 2015 Field Course Reader and Syllabus	Donald Walker	07/07/2015

Products

Books

Book Chapters

Conference Papers and Presentations

Romanovsky, V.E., Cable, W.G., Kholodov, S.S., at al. (2014). *Changes in permafrost and active-layer thickness due to climate in the Prudhoe Bay region and North Slope, AK.*. Arctic Change 2014. Ottawa. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Kanevskiy, M., Shur, Y., Matyshak, G., et al. (2014). *Degradation and recovery of ice wedges in relation to road infrastructure*

in the Prudhoe Bay Oilfield, AK.. Arctic Change 2014. Ottawa. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Buchhorn, M., Kanevskiy, M., Matyshak, G., et al. (2014). *Effects of 45 years of heavy road traffic on permafrost and tundra along the Spine Road at Prudhoe Bay, Alaska.*. Arctic Change 2014. December 8-12, 2015.. Ottawa. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Walker, D.A., Raynolds, M.K., Kumpula, T., Shur, Y., Kanevskiy, M.Z., Leibman, M.O., Khomutov, A., Ambrosius, K., Buchhorn, M., Epstein, H.E., Forbes, B.C., Kofinas, G., Maytshak, G.V., Romanovsky, V. and Wirth, L. (2014). *Rapid Arctic Transitions in Relation to Infrastructure and Climate Change: Comparison of the Permafrost and Geoecological Conditions in the Bovanenkovo Gas Field, Russia and the Prudhoe Bay Oil Field, Alaska.*. AGU Fall Meeting, December 15 - 19.. San Francisco. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Raynolds, M.K., Walker, D.A., Buchhorn, M., Wirth, L.M. (2014). *Vegetation changes related to 45 years of heavy road traffic along the Spine Road at Prudhoe Bay, Alaska.*. Arctic Change 2014. Ottawa. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Inventions

Journals

Bhatt, U. S., D. A. Walker, J. E. Walsh, E. C. Carmack, K. E. Frey, W. N. Meier, S. E. Moore, F.-J. W. Parmentier, E. Post, V. E. Romanovsky, and W. R. Simpson. (2014). Implications of Arctic sea ice decline for the Earth system.. *Annual Review of Environment and Resources*. 39 57. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: doi:10.1146/annurev-environ-122012-094357.

Bieniek, PA, US Bhatt, DA Walker, MK Raynolds, JC Comiso, HE Epstein, JE Pinzon, CJ Tucker, RL Thoman, H Tran, N Mölders, M Steele, J Zhang, and W Ermold. (2015). Climate drivers of changing seasonality of Alaska coastal tundra vegetation productivity. *Earth Interactions*. . Status = UNDER_REVIEW; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Raynolds, M. K., Walker, D. A., Ambrosius, K. J., Brown, J., Everett, K. R., Kanevskiy, M., et al.Global Change Biology, (20), 1211–1224. http://doi.org/10.1111/gcb.12500 (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 1211. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: http://doi.org/10.1111/gcb.12500

Licenses

Other Products

White paper for ICARP III.

The Rapid Arctic Transitions due to Infrastructure and Climate (RATIC) initiative is 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. This white paper is provided as input to the Third International Conference on Arctic Research Planning (ICARP III).

The information presented here is summarized from the RATIC activities at the Arctic Change 2014 conference, 8-12 December 2014, in Ottawa, Canada, and meetings during the Arctic Science Summit Week, 23-30 April 2015, in Toyama, Japan.

This white paper consists of five infrastructure case studies, a summary of the messages that emerged from the case studies and RATIC workshops, and recommendations for the ICARP III process.

Key conclusions

The key messages emerging from the case studies and workshops are:

1. There is a need to examine the cumulative effects of infrastructure in the context of Arctic social-ecological

systems. Understanding the emergence and consequence of cumulative effects of infrastructure and climate change on high-latitude social-ecological systems requires the consideration of a number of dimensions. These include 1) accounting for the drivers of infrastructure and infrastructure change including the interaction of biophysical and social dynamics in Arctic Social-Ecological Systems; 2) evaluating the effects on ecosystem services, human residents and industry; and 3) crafting effective systems of governance to support adaptation to and mitigation of change. Framing these dimensions holistically requires transdisciplinary approaches that link science with policy.

2. Permafrost response to a combination of infrastructure and climate change is a pressing ecological issue that has large social costs. Permafrost thawing and its associated impacts on natural and built environments were clearly identified as priority issues across all regions of the Arctic, but the specific issues related to permafrost differ in each region studied. In communities and urban environments, changes to the thermal regimes of soils that support houses, roads, airports, and large buildings have large economic and social consequences. Ecological changes caused by thermokarst and other permafrost-related geomorphic processes are exacerbated by the soil-warming affects of infrastructure and are affecting the structure of landscapes, hydrological patterns, snow distribution, ecosystems, and the use of the land by northern residents and industry. These cumulative permafrost changes come at a time of intense demographic and socio-economic development in the Arctic.

3. The indirect effects of infrastructure exceed the direct effects of the planned footprints. Evaluating and predicting the effects of infrastructure and climate must extend beyond the direct area covered by roads, pipelines and facilities. Assessments of effects should include cumulative impacts of climate change and infrastructure on the adjacent ecosystems, local communities, regions, and areas outside the Arctic.

4. New tools are needed to monitor infrastructure and landscape changes and to develop sustainable approaches for future development. These include but a are not limited to: 1) integrated, interdisciplinary, whole-system approaches for examining the drivers and effects of infrastructure and climate change; this echoes the conclusions from the 2003 report by the U.S. National Research Council calling for regional ecosystem-level studies; (2) advanced GIS and remote sensing tools for studying change over large areas and in landscapes beyond the direct footprint of the infrastructure, for tracing small-scale disturbances that individually cover relatively small areas but which in total affect large landscapes, and for detecting changes to permafrost-related landforms such as landslides and thermokarst; (3) new techniques to model and predict the effects of fragmentation of large intact ecosystems, which have potentially large, long-term effects on fish and wildlife habitat, subsistence use of the land by indigenous people, and wilderness values; and (4) new scenario modeling approaches that involve the details of the affected landscapes and ecosystems, as well as foreseeable changes due to climate, economies, politics, demographics, land-use, and technological factors.

5. Infrastructure issues are not adequately addressed by any of the IASC working groups nor in many national-level Arctic science plans. IASC and ICARP III could play a key a role in helping to promote international projects and programs focused on sustainable methods of infrastructure development. Several programs in different countries provide examples of scientific approaches to sustainable infrastructure. The case studies cited in this paper provide some examples, including the Integrated Regional Impact Studies (IRIS) and the Arctic Development and Adaptation to Permafrost in Transition (ADAPT) program in Canada; the Finnish-sponsored Environmental and Social Impacts of Industrialization in Northern Russia (ENSINOR); the U.S. interagency North Slope Science Initiative (NSSI); and the National Science Foundation (NSF) Arctic Science, Engineering, and Education for Sustainability (ArcSEES) initiative in Alaska. Many other examples are available from industry and governments that are continuing to explore and develop useful approaches for sustainable infrastructure development.

Recommendations

Several steps were suggested to develop scientific research plans aimed at sustainable infrastructure development. The scope of the challenge includes: (1) examining the drivers of Arctic infrastructure in different Arctic cultures, economic systems, political environments, and ecological systems; (2) monitoring and understanding the vulnerabilities, resilience and full cumulative effects of Arctic infrastructure on the diverse group of Arctic social-ecological systems that are currently undergoing change; (3) planning, managing, and shaping future Arctic infrastructure; and (4) involving the Association of

Polar Early Career Scientists (APECS) in the process to provide new energy and new ideas and to assure continuity of the effort through the next decade of Arctic research. Future planning needs to include consideration of the widely divergent political systems, economies, cultures, communities and landscapes present in the Arctic, fragmentation of presently intact natural landscapes by large networks of roads and pipelines, Arctic urban infrastructure, engineering of subarctic infrastructure, and Arctic off-shore infrastructure.

As first steps, the RATIC group recommends that the combined IASC Cryosphere, Social & Human, and Terrestrial Working Groups work together to: (1) Finish the RATIC white paper and post it on the ICARP III website as a product of the ICARP III planning process; (2) publish a summary of the white paper and follow-up synthesis activities in an appropriate peer-reviewed journal; (3) develop an interdisciplinary IASC Infrastructure Action Group that includes participation by members of all IASC working groups and APECS; (4) incorporate infrastructure-related issues more explicitly in the IASC working groups' research priorities; (5) promote regular infrastructure workshops at international scientific meetings; (6) emphasize the need for social-ecological-system studies in relationship to infrastructure; and (7) promote infrastructure-related themes in future international research initiatives.

Other Publications

Walker, Donald A., Marcel Buchhorn, Mikhail kanevskiy, George V. Matyshak, Martha K. Raynolds, Yuri L. Shur, Lisa M. Wirth (2015). *Infrastructure-Thermokarst-Soil-Vegetation Interactions at Lake Colleen Site A, Prudhoe Bay, Alaska*. Data presented in this report were collected for a study that focuses on thermokarst in relationship to both climate change and oilfield infrastructure. a fuller description of the landscape and permafrost changes in the Prudhoe Bay oilfield appears in Walker et al. (2014). the main objectives of our 2014 field program were to document the extent and effects of road dust and road-related flooding to the topography, landforms, permafrost, soils, and vegetation. We were partic- ularly interested in changes to the permafrost and ice-wedges. During 2-13 august 2014, we examined thermokarst features that were easily accessible with- in the lake colleen region. Full data report available at http://www.geobotany.uaf.edu/library/pubs/WalkerDA2015_agc15-01_datarpt.pdf.. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Walker, D A, Raynolds, M. K., Buchhorn, M., & Peirce, J. L. (Eds.). Alaska Geobotany Center, University of Alaska, AGC Publication 14-01. (2014). *Landscape and permafrost change in the Prudhoe Bay Oilfield, Alaska. University of Alaska, AGC Publication 14-01. Full document at http://www.geobotany.uaf.edu/library/pubs/WalkerDA2014_agc14-01.pdf*. A major synthesis of the 62-year history of landscape and permafrost changes in the Prudhoe Bay region has recently been completed and reports major increases in both infrastructure-related and non-infrastructure-related thermokarst since 1990. Six chapters: 1 cumulative geoecological effects of 62 years of infrastructure and climate change in ice-rich permafrost landscapes, Prudhoe bay oilfield, alaska 1 Martha K. Raynolds, Donald A. Walker, Kenneth J. Ambrosius, Jerry Brown, Kaye R. Everett, Mikhail Kanevskiy, Gary P. Kofinas, Vladimir E. Romanovsky, Yuri L. Shur, Patrick J. Webber 2 supplementary information regarding ice-rich permafrost at Prudhoe bay 15 Yuri L. Shur, Mikhail Kanevskiy, Vladimir E. Romanovsky, Kaye R. Everett, Jerry Brown, Donald A. Walker 3 supplementary information regarding calculation of impacts of oilfield development, north slope, alaska 23 Kenneth J. Ambrosius 4 supplementary information regarding the integrated Geoecological and historical change Mapping (iGhcM) method 33 Donald A. Walker, Martha K Raynolds, Patrick J. Webber, Jerry Brown 5 Ground-based studies of the effects of roads on landscapes and permafrost in the Prudhoe bay oilfield, alaska 67 Donald A. Walker, Mikhail Kanevskiy, Yuri L. Shur, Marcel Buchhorn, Martha K. Raynolds, George V. Matyshak and Lisa M. Wirth 6 conclusions. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Patents

Technologies or Techniques

Thesis/Dissertations

Buchhorn, Marcel. *Ground-based hyperspectral and spectro-directional reflectance characterization of Arctic tundra vegetation communities: field spectroscopy and field spectro-goniometry of Siberian and Alaskan tundra in preparation of the EnMAP satellite mission.*. (2014). Potsdam University. Acknowledgement of Federal Support = No

Websites

Supporting Files

Filename	Description	Uploaded By	Uploaded On
RATIC White Paper - Draft for Review(2)20150515.pdf	White paper for Rapid Arctic Transitions due to Infrastructure and Climate (RATIC) *Draft presented at the ASSW 2015 for the ICARP 2015.	Donald Walker	07/07/2015
Bhatt2014Annual Review of Environment and Resources.pdf	Bhatt, U. S., Walker, D. A., Walsh, J. E., Carmack, E. C., Frey, K. E., Meier, W. N., et al. (2014). Implications of Arctic sea ice decline for the Earth system. Annual Review of Environment and Resources, 39, 57–89.	Donald Walker	07/07/2015

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Walker, Donald	PD/PI	5
Kofinas, Gary	Co PD/PI	1
Shur, Yuri	Co PD/PI	1
Buchhorn, Marcel	Postdoctoral (scholar, fellow or other postdoctoral position)	4
Raynolds, Martha	Postdoctoral (scholar, fellow or other postdoctoral position)	4
Wirth, Lisa	Other Professional	1

Full details of individuals who have worked on the project:

Donald A Walker
Email: ffdaw@uaf.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 5

Contribution to the Project: Project direction, organized field work, conducted vegetation studies, wrote data report, and edited major volume describing landscape and permafrost change in the Prudhoe Bay region, wrote major sections and edited RATIC white paper for ICARP III>

Funding Support: NASA awards for PreABoVE, and Land Cover Land Use Change in the Yamal Peninsula, Russia

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: Coordinated the human dimensions portion of the project

Funding Support: Belmont Award, EPSCoR funding

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: Coordinated the permafrost portion of the study

Funding Support: Other NSF support for work at Prudhoe Bay

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: 4

Contribution to the Project: Field work, GIS/remote sensing lab manager, building new facility

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

International Collaboration: Yes, Germany
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: 4

Contribution to the Project: Field research, mapping, writing publications

Funding Support: This project

International Collaboration: No
International Travel: No

Lisa Wirth
Email: lisa@gina.alaska.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

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

Funding Support: This project, NASA PreABoVE project

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

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

What other collaborators or contacts have been involved?

George Matyshak, Lomonosov State University, soil studies for Lake Colleen Site A project.

Impacts

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

The documents published to date (Raynolds et al. 2014, Walker et al. 2014) are the most recent and most complete assessments of the combined effects of human development and climate change for any area in the Arctic. The RATIC

initiative is contributing in a major way toward developing an international initiative through IASC that will focus on infrastructure issues and sustainable development in the Arctic.

What is the impact on other disciplines?

The RATIC initiative has pulled scientists from other fields, including permafrost researchers, and social scientists, to develop a more interdisciplinary approach to examining the combined effects of infrastructure and climate change.

What is the impact on the development of human resources?

The education component is training students in interdisciplinary Arctic research. The new Execurtive Director for ARCUS took the field course in 2015 and has stated that this will have high impact regarding his knowledge of the Arctic and understanding of the key issues related to Arctic Environmental Change. Several post docs and and early career Arctic scientists are involved in the research. A large group of international scientists are involved with the RATIC initiative.

What is the impact on physical resources that form infrastructure?

The project has contributed to a major update and renovation of the Arctic Geobotany Center's GIS and remote sensing facility.

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 helping to develop a web-based Alaska Arctic Geoecological Atlas.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?

The project is contributing to public understanding of the issues related through the field course and public seminars.

Changes/Problems

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

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.
Nothing to report.