Arctic Science Summit Week 2023
Networking Lunch and Poster Session, 12:30-14:00
Open Community Meeting, 14:00–18:00 (all times CEST)
Hörsaal 3, Main Building, University of Vienna & Online

Sponsored by IASC

Towards Sustainable Infrastructure: Environmental, Technological, and Societal Impacts of Development in the Arctic

ABSTRACTS AND BIOS / 20 FEBRUARY 2023

ORAL PRESENTATIONS

Permafrost as a frozen commons

Kelsey E. Nyland, Vera V. Kuklina, Nikolay I. Shiklomanov, Dmitry A. Streletskiy

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In this presentation we review several examples of traditional and urban both settlement and intersettlement infrastructure constructed from, and/or highly dependent on, stable permafrost conditions. Using the Institutional Analysis and Development (IAD) framework, we discuss how permafrost, by way of infrastructure, can be considered a commons by providing ecosystem services to many Arctic and subarctic communities. Permafrost as a commons is at risk of mismanagement and depletion. Settlement infrastructure types reviewed in this presentation include heavy industry and urban roads and building foundations in Norilsk, Russia, and traditional ice cellars and light-load road networks and building foundations in the majority Iñupiat community of Utqiaġvik, Alaska. Examples of inter-settlement infrastructure are drawn from studies of informal roads in the northern Baikal region, Russia, and Khövsgöl Aimag, Mongolia. Long-term monitoring of permafrost and infrastructure degradation in both settlement and intersettlement studies provide the basis for our discussion of the negative physical, cultural, and economic impacts of climate warming on permafrost-dependent infrastructure. Treating permafrost as a common resource in both traditional indigenous and urban contexts can potentially improve sustainable community planning through culturally appropriate and cost-effective adaptation and mitigation strategies. We conclude with a demonstration of several conceptual models fit to each infrastructure type discussed.

Changing reindeer grazing patterns in the border area of Finland and Norway, combining UAV and Eddy covariance methods

Miguel Villoslada[1], Timo Kumpula[1], Henni Ylänne[1], Sari Juutinen[1,2]

[1] Department of Geographical and Historical studies, University of Eastern Finland; [2] Finnish Meteorological Institute, Climate System Research, Helsinki, Finland

Shrubification of arctic tundra wetlands alongside with changes in the coverage and volume of lichens are two well-documented processes in the Fennoscandian tundra. A rapidly warming climate and changes in reindeer grazing patterns are driving shifts in the carbon feedbacks and altering local microclimate conditions.

The study area is located in the tundra zone, between the Finnish-Norwegian border. In the mid 1950s, a reindeer fence was built along the border, thus separating and creating two different

reindeer grazing strategies. Here, we present a toolset of Unmanned Aerial Systems and Machine Learning algorithms that enables highly accurate monitoring of landcover change dynamics in the sub-arctic tundra. While reindeer graze only during winter in the Norwegian side, grazing occurs all year round in the Finnish side. We combined UAV data with an ensemble of machine learning algorithms to map the extent of woody shrubs, quantify their above-ground biomass, growth patterns and associated topsoil moisture at two wetlands across the border. The results show a clear expansion of willows in the Norwegian side of the border, associated to a lower reindeer grazing pressure.

To answer how reindeer summer grazing affects vegetation, wetness, albedo, and ecosystem CO2 and CH4 exchange, we also set-up an eddy covariance (EC) measurement station and chamber measurement points on a high-elevation peatland. The EC footprint has a radius ca. 30 m and it captures both sides of the fence allowing comparing the effects of grazing, i.e. different willow density, on peatland's C-exchange. Here we introduce our experimental set-up and report preliminary results on how the different grazing practices affect peatland vegetation and ecosystem CO2 and CH4 exchange.

Multi-scale spatiotemporal monitoring of permafrost degradation using distributed acoustic and temperature sensing

Ming Xiao

Department of Civil & Environmental Engineering, Pennsylvania State University, University Park, PA, USA

This presentation will introduce an ongoing collaborative research project that uses distributed acoustic sending (DAS) and distributed temperature sensing (DTS) to monitor permafrost degradation from minute to decadal scales and from sub-meter to kilometer scales in a tundra of Arctic Alaska. The research team installed 2km DTS and DAS fiber optic cables in disturbed and undisturbed permafrost in Utqiaġvik, Alaska in summer 2021. We have been collecting continuous temperature data and ground vibration data that can be correlated to permafrost subsurface conditions and characteristics. The allows in-situ monitoring of permafrost changes with the climate in multi spatial and temporal scales.

Building Arctic Futures: Infrastructure Projects and Local Scenarios

Olga Povoroznyuk[1], Nikita Strelkovskii[2], Peter Schweitzer[1]

[1] Department of Social and Cultural Anthropology, University of Vienna, Austria;
[2] International Institute for Applied Systems Analysis, Laxenburg, Austria

The ERC Advanced Grant project *InfraNorth* explores the local impacts of existing and planned transport infrastructures in the Arctic. Project case studies are located in Alaska, Canada, the Faroe Islands, Finland, Greenland, Norway and Sweden, while initially planned fieldwork in Russia was suspended due to the war. Apart from individual and focus group interviews, observations, surveys and life histories, our array of methods includes the co-production of future scenarios with selected local communities.

Scenarios are plausible and thought-provoking narratives about how the future could look like. Based on recent scenarios of shipping in the Arctic, four plausible scenarios are developed for each of the communities using a multi-level (global-regional-local) scenario building framework. They are accustomed to specific regional and local impacts of global and pan-Arctic development drivers such

as infrastructural modernization and technological innovation, climate change and resource extraction, militarization and population trends. They intend to elicit discussions and imaginations of local residents participating in the workshops regarding desirable and plausible futures of their communities vis-à-vis ongoing and planned (transport) infrastructure projects.

To date, two scenario sets have been developed for Churchill, Manitoba, and Kirkenes, Finnmark. Each scenario outlines a development pathway for the communities until 2050 under various combinations of relevant global and regional trends. These scenarios focus on various types of transport infrastructure and will be discussed at local scenario workshops taking place in Churchill and Kirkenes in 2023. One or two additional local workshops will be held tentatively, in Nome, Alaska and/or in Longyearbyen, Svalbard in 2024. The results of the workshops will be analyzed together with local residents to co-produce reports or popular science brochures about futures of Arctic coastal communities, as well as to be included in academic publications.

The 4th International Conference on Arctic Research Planning (ICARP IV): A Multi-year Process (2022 - 2026) for Diverse, Pan-Arctic Input and Engagement

Sandy Starkweather

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The International Arctic Science Committee (IASC) is coordinating a multi-year planning process for the Fourth International Conference on Arctic Research Planning (ICARP IV) lasting from 2022 until 2026 that will engage Arctic researchers, Indigenous Peoples, policy makers, residents and stakeholders from around the world to collegially discuss the state of Arctic science, the place the Arctic occupies in global affairs and systems. ICARP IV will (1) consider the most urgent knowledge gaps and Arctic research priorities and needs for the next decade, and (2) explore avenues to address these research needs.

One of the main goals for ICARP IV is a truly inclusive, diverse, and engaging process to ensure that the scientific goals for the next decade are firmly grounded on the advice and needs of Arctic scientists and science organizations, Indigenous peoples and Arctic residents, and stakeholders. The first stage of the ICARP IV process will focus on seeking community input throughout 2023 with a diverse set of engagement activities (in-person and online). Individuals, groups, networks, institutions and organizations are encouraged to organize projects and events as part of this ICARP IV engagement process and report their outcomes back to the ICARP IV International Steering Committee to ensure they are included in the development of the ICARP IV research priorities and implementation plans.

RATIC Past and Future

Skip Walker

Institute of Arctic Biology, University of Alaska Fairbanks, AK, USA

The Rapid Arctic Transitions due to Infrastructure and Climate Change (RATIC) is an "*international 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 infrastructure and climate change*". In preparation for the breakout discussions of possible futures for RATIC, this paper traces the history from the first RATIC workshop and science session at the Arctic Change 2014 conference (Ottawa) thru its recent status as the Infrastructure Action Group of T-MOSAiC. It includes some of the successes, achievements, and recent developments of RATIC participants. A

key piece of RATIC history was the development of a white paper presented to the ICARP III planning process for the 2015–2024 decade. We should now consider how to participate in the ICARP IV process. Do we continue RATIC under the same name, logo and emphasis, which were strongly focused on oilfields, roads, and railways and cumulative environmental impacts? Or should we take a new direction more in line with the current emphasis on social impacts and sustainability. In my opinion, although we never had a concrete science plan, we achieved most of the goals laid out in the ICARP III white paper. One of the most successful activities of RATIC was the Arctic Infrastructure On-line Science Talk series during the COVID years of 2021–2022. The monthly meetings were at the heart of the original RATIC conception — a "forum for sharing new ideas" along a wide variety of infrastructure-related topics.

POSTERS

Artificial light at night discloses large regional differences in industrial activity across the Arctic

Cengiz Akandil, Elena Plekhanova, Nils Rietze, Gabriela Schaepman-Strub

University of Zurich, Switzerland

As the warming climate facilitates industrial development in the Arctic, direct anthropogenic impacts of industrial development on the Arctic ecosystem might exacerbate the effects of climate change. Until now the analysis of the industrial human activity and infrastructure development in the Arctic was generally local such as at the Prudhoe Bay oil fields or Bovanenkovo oil fields. Some recent studies also showed the current state of the infrastructure development in the Pan Arctic. However, there is no study on past activity and how the industrial development and urbanization changed throughout, years, allowing us to determine the rate of development at pan-Arctic scale and to quantify the total area that is affected by industrial human activity through time, including industrial areas that that have been abandoned. We close this this gap by analyzing industrial human activity and urbanization from 1992 to 2013 using Artificial Lights at Night (ALAN), because remotely sensed artificial lights deliver the signature of human activity.

Recent industrial development across the Arctic as visible from space

Annett Bartsch[1,2], Georg Pointner[1,2], Ingmar Nitze[3], Aleksandra Efimova[1,2], Guido Grosse[3], Peter Schweitzer[4,2]

[1] b.geos, Korneuburg, Austria; [2] Austrian Polar Research Institute, Austria; [3] Permafrost Research Section, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Potsdam, Germany; [4] Department of Social Anthropology, University of Vienna, Austria

The SACHI (Sentinel-1/2 derived Arctic Coastal Human Impact) dataset has been primarily developed as part of the HORIZON 2020 project Nunataryuk. It covers a 100-km buffer from the Arctic Coast (land area), for areas with permafrost near the coast. It is based on Sentinel-1 and Sentinel-2 data from 2016-2020 using the algorithms described in Bartsch et al. (2020). It is a supplement to Bartsch et al. (2021). SACHI includes polygons of all identified objects with infrastructure/impact classes and auxiliary information: permafrost status and trends; nightlight radiance; vegetation zone; Normalized Difference Vegetation Index trends; settlement names (closest known, max 40 km distance incl. land use/industry type). SACHI class values include: 1=linear transport infrastructure;

2=buildings (and other constructions such as bridges); and 3=other impacted area (includes gravel pads, mining sites).

Sustainable Energy Supply in Rural Arctic Areas

Magnus de Witt

Department of Engineering, Reykjavik University, Iceland

The focuses on which energy resources are available in the Arctic and how the various resources can be har-vested with different mature energy technology options for remote Arctic communities. Mature energy generation technology means that the operation under harsh and cold climatical conditions is well proven. Further-more, the current energy situation among remote Arctic communities will be mapped out, with an analysis of which energy sources are used, the share of the different sources, and the energy demand of remote communities. After explaining the different energy generation options and main drivers for using renewable energy in remote Arctic communities, three case studies have been conducted. The case studies examine the viability of a potential energy transition for Arctic communities. The case studies also share some insights from field visits in remote communities on generating electricity with renewables and potential energy saving potentials. The last part elaborates on different integration strategies for renewable energy options. The focus lies on how to finance the energy transition in remote Arctic communities, which can help to structure the energy transition process financially. The dissertation finishes with an overall conclusion on the importance of renewable energy for Arctic communities. The research shows that renewable energy can be vital for remote communities to be-come more energy independent and lower the energy cost burden.

ICARP IV International Conference on Arctic Research Planning: A Multi-year Process (2022–2026) for Diverse, Pan-Arctic Input & Engagement

Matthew Druckenmiller

University of Colorado Boulder, CO, USA

The International Conference on Arctic Research Planning (ICARP) is a decadal Arctic research planning process organized by the International Arctic Science Committee (IASC) every 10 years since 1995. It engages Arctic researchers, Indigenous Peoples, residents, policy makers, residents and stakeholders from around the world in a discussion of the state of Arctic science and the place the Arctic occupies in global affairs and systems. ICARP IV is underway. It will be a multi-year process to consider the most urgent knowledge gaps and Arctic research priorities and needs for the next decade, and to explore collaborative avenues to address these research priorities. Individuals, groups, networks, institutions, and organizations are encouraged to organize projects and events as part of ICARP IV and to seek endorsement of their activity from the ICARP IV International Steering Committee. Endorsed contributions and their outcomes will inform ICARP IV Research Priority Teams and contribute to final ICARP IV outcomes and implementation plans.

High-Resolution Data from Integrated Micrometeorological and Geophysical Studies within an Arctic City: Preliminary Results from Utqiaġvik, Alaska

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Environmental Sciences, University of Virginia, Charlottesville, VA, USA; [4] Cold Regions Research and Engineering Laboratory, U.S. Army Corps of Engineers, Fort Wainwright, AK, USA

The Arctic is a highly dynamic and extreme environment at the forefront of accelerated climate change. Situated on the coast of northern Alaska, 330 miles north of the Arctic Circle, the city of Utqiaġvik is built entirely on continuous permafrost with varying ice content. Since the 1970s, critical infrastructure, including water and electrical utilities, gravel roads, sanitation facilities, snow fences, schools, housing, and other government buildings were built. Most of these structures are on raised pilings driven into the underlying permafrost to mitigate heat transfer to the ground. Due to anthropogenic heat and a warming climate, Utqiaġvik faces challenges from destabilized permafrost, causing structural deformation of buildings and infrastructure. Although there are numerous studies on permafrost, less has been done on how urbanization and land use contribute to permafrost degradation. As part of a five-year study in partnership with the city of Utqiaġvik, this NSF-funded project has established an array of micrometeorological and ground based sensors at five study sites: a residential building, a public utilities complex, a new hospital, a gas line node, and a tundra control site. The data from the sensor arrays, combined with geophysical measurements of subsurface permafrost conditions will provide constraints for the development of resilient design strategies. Repeat LiDAR surveys identify changes in structures and land surface over time. Preliminary results from the micrometeorological sensor installation in the summer of 2022, combined with geophysical surveys from 2021-2022, indicate highly variable urban microclimate, surface and subsurface ground conditions. Localization of snow and surface water accumulation due to disturbed natural surface drainage and/or presence of human-made structures plays a key role in destabilizing the thermal regime of the underlying permafrost. However, reduced solar insolation beneath raised structures with adequate thermal isolation decreases the depth of the active layer and enhances permafrost stability. These competing effects reveal the complexity of interactions within an Arctic urban environment and the importance of integrated studies to monitor changing conditions for future development and adaptation strategies for Utqiaġvik.

Medium-scale Cultivation of Microalgae in Svalbard

Jana Kvíderová[1,2,3], Karel Šnokhous4, Jiří Liška1, Jaromír Lukavský[1], Pavel Přibyl[1], Lenka Procházková[1], Josef Elster[1,2]

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The adaptation mechanisms of polar microalgae evolved to withstand the harsh polar environment characterized by low temperature, freeze-thaw cycles, desiccation, salinity, and high and variable photosynthetically active and ultraviolet radiation. Hence, polar microalgae developed ecological, physiological, and molecular defensive and adaptive strategies, which include the synthesis of a tremendous diversity of compounds originating from different metabolic pathways which protect them against the above-mentioned stresses. These pathways and metabolites could be prospective for biotechnological applications in low temperatures which could reduce the impacts of human activities on pristine polar environments and provide novel environment-friendly technologies for exploitation of the Polar Regions, namely the Arctic. Therefore, development of new types of photobioreactors to provide suitable and controlled conditions for microalgal growth and/or

biologically active compound production is necessary, especially in medium (tens of liters) and large (hundreds of liters or even more) scales.

Understanding infrastructure risk due to permafrost thaw to inform decision-making in Point Lay, Alaska

Jana L. Peirce[1], Benjamin M. Jones[2], Billy G. Connor[2], Mikhail Kanevskiy[2], Yuri Shur[2], Tracie Curry[3], Peppi Bolz[4]

[1] Alaska Geobotany Center, Institute of Arctic Biology, University of Alaska Fairbanks, AK, USA; [2] Institute of Northern Engineering, University of Alaska Fairbanks, AK, USA;
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The Native Village of Point Lay has been identified as the second most permafrost thaw-affected community in Alaska. Issues associated with thawing permafrost and terrain subsidence have dramatically increased during the last decade resulting in the failure of critical infrastructure and increasing risks to life, health and safety. In June 2022, seven researchers from the University of Alaska Fairbanks and Northern Social-Environmental Research traveled to Point Lay to observe, study, and discuss the effects of thawing permafrost on homes and other critical infrastructure in the village. During our research, we (1) studied permafrost properties and ground-ice conditions in three main terrain units (elevated areas, slopes, and drained-lake basins), (2) mapped the community with a drone to quantify the effect of thermokarst on village infrastructure, (3) conducted visual assessments on the effects of thawing permafrost on piling foundations, and (4) interviewed residents on their observations and experiences of permafrost thaw to better understand the impact of landscape changes as well as community concerns and information needs. The assessment of ground-ice content and comparative permafrost changes in built-up areas and an undeveloped area adjacent to the townsite showed that while climate warming has contributed to the permafrost thaw in Point Lay, adverse impacts of infrastructure have been a major driver of subsidence. To ensure the relevance of our research to local and regional decision-makers, we met with engineers, planners and policymakers before and after the visit to discuss research plans, exchange data, and share findings, including seven takeaways that can inform community-based decisions.

Arctic Coastal Communities Global Connectivity and Ethnography of Maritime Infrastructure

Olga Povoroznyuk

Department of Social and Cultural Anthropology, University of Vienna, Austria

The Arctic has been conceptualized as a global region experiencing unprecedented environmental change, resource extraction, indigenous movement, and growing connectivity with the Arctic Ocean often referred to as “the new Mediterranean.” Since the beginning of Russia's invasion of Ukraine the region has been turning into an arena for new military competition and struggles for access to maritime resources and seaways. This new Arctic geopolitics might impact infrastructural development, connectivity and well-being of coastal communities.

Transport Infrastructures and Sustainable Northern Communities

Katrin Schmid

University of Vienna, Austria

The ERC Advanced Grant Project “InfraNorth” examines how residents of the Arctic engage with transport infrastructures and their intended and unintended local consequences. We ask, “What is the role of transport infrastructures in sustaining arctic communities?” We take an anthropological and geographic approach to this topic to examine individual case studies in the European, Russian and North American Arctic. Our approach combines ethnographic research with mapping, future scenario workshops, quantitative population data, a survey, and archival research. My doctoral research examines the intersection of infrastructure planning and development, with the futures Nunavut residents imagine for their communities. Within this, I ask how these infrastructures can support access to country food in the territory.

Assessing Micrometeorological and Geophysical Differences Related to the Built Environment in Utqiaġvik, Alaska

Mirella Shaban[1], MacKenzie Nelson[1], Leena Cho[2], Chan Charoonsophonsak[3], Georgina Davis[3], Thomas Douglas[4], Tobias Gerken[5], Claire G Griffin[1], Matthew G Jull[2], Luis Felipe Rosado Murillo[6], Lars Nelson[7], Caitlin D Wylie[8], Howard E. Epstein[1]

[1] Department of Environmental Sciences, University of Virginia, Charlottesville, VA, USA; [2] School of Architecture, University of Virginia, Charlottesville, VA, USA; [3] Cold Climate Housing Research Center, Fairbanks, AK, USA; [4] Cold Regions Research and Engineering Laboratory, U.S. Army Corps of Engineers, Fort Wainwright, AK, USA; [5] School of Integrated Sciences, James Madison University, Harrisonburg, VA, USA; [6] Technology Ethics Center, University of Notre Dame, IN, USA; [7] TRIBN LLC, Utqiaġvik, AK, USA; [8] School of Engineering, University of Virginia, Charlottesville, VA, USA

The effects of permafrost thaw are increasingly felt throughout Arctic communities, due to changes in regional climates, with impacts on homes, businesses, and livelihoods. Understanding and monitoring the shifts in Arctic environments can aid in the remediation and mitigation of permafrost thaw. An array of micrometeorological sensors was deployed throughout Utqiaġvik, Alaska in June of 2022 to monitor and analyze differences in micrometeorological conditions and trends at various locations near buildings and infrastructure over a five-year period. Air temperature, relative humidity, solar radiation, wind direction, wind speed, soil volumetric water content (VWC), and ground temperature measurements are currently being collected at five sites: Taġiuġmiullu Nunamiullu Housing Authority (TNHA), Samuel Simmonds Memorial Hospital (SSMH), Barrow Utilities and Electrical Cooperative, Inc. (BUCEI) (two sites), and the Barrow Environmental Observatory (BEO). These measurements are complemented by annual thaw depth measurements, ground penetrating radar and electrical resistivity tomography analyses of ground ice conditions, as well as repeat LiDAR measurements for ground subsidence and structural changes.

URban Sustainability in Action: Multi-disciplinary Approach through Jointly Organized Research schools (URSA MAJOR)

Jenny Turton[1], Igor Ezau[2,3], Lasse Pettersson[3], Vera Kuklina[4], Sobah Abbas Petersen[5,6], Alenka Temeljotov-Salaj[5]

[1] Arctic Frontiers; [2] The Arctic University of Norway; [3] NERSC; [4] George Washington University, Washington, DC, USA; [5] Norwegian University of Science and Technology; [6] SINTEF

Twenty-three Students from five countries (Germany, Norway, Finland, India and USA) gathered for the 2022 Autumn school focusing on Urban Sustainability in the Arctic, a holistic socio-environmental programme for “Smart Cities” with an Arctic focus. The programme included: Dedicated science sessions at Arctic Frontiers 2023 on 'City Transformation by and for Citizens using

Digital Technologies and Visualization' with 14 oral talks and 4 posters; Meetings at Arctic Frontiers 2023 with county councils, Mayors and other stakeholders; Presentations at European Geosciences Union (EGU) conference in 2022 and 2023; Involved in discussions 'Urban and Societal Developments in Alaska and Norway' in Washington DC, September 2022, with academic and business stakeholders.

PRESENTER BIOS

Sari Juutinen is a post doc researcher working in the Finnish Meteorological Institute (FMI). Her research includes ecosystem-atmosphere carbon exchange from leaf to catchment level, lateral carbon and matter fluxes, sediment records and geochemical tracers of matter fluxes, and, in particular, the role of vegetation and plant communities in ecosystem functioning.

Timo Kumpula is a professor in Environmental Geoinformatics at the Department of Geographical and Historical studies, UEF. Kumpula's research has focused on the boreal and arctic environments, social-ecological systems, reindeer pastures, landuse and landcover changes utilizing remote sensing and geoinformatics.

Olga Povoroznyuk is a PostDoc Researcher and Lecturer at the Department of Social and Cultural Anthropology, University of Vienna. Her research interests include the issues of infrastructure and development, identity, ethnicity and indigeneity, postsocialism, climate and environmental changes in the Circumpolar North and beyond. Her research has been focused on large-scale infrastructures and modernization and nation-building projects in Post-Soviet Siberia. Currently, she works as a research coordinator and a study region lead in the ERC project "InfraNorth" and explores the role of maritime and other transport infrastructure in social dynamics, connectivity and sustainability of coastal communities in Northeast Siberia, Northern Norway and Alaska. Olga Povoroznyuk is also an Austrian delegate to the IASC Social and Human Working Group, a member of the steering committee of IASC research initiative RATIC and a researcher and a social science media coordinator at the Austrian Polar Research Institute.

Peter Schweitzer is currently Professor of Anthropology at the Department of Social and Cultural Anthropology of the University of Vienna. He is a founding member of the Austrian Polar Research Institute and served as its director from 2016-2020. From 2014-2022, he was one of two Austrian representatives to the Social and Human Working Group (SHWG) of the International Arctic Science Committee (IASC) and was its first chair from 2011 to 2015. Schweitzer served as president of the International Arctic Social Science Association (IASSA) from 2001 to 2005 and is Professor Emeritus at the University of Alaska Fairbanks. His theoretical interests range from kinship and identity politics to human-environmental interactions, including the social lives of infrastructure and the community effects of global climate change; his regional focus areas include the circumpolar North and the former Soviet Union. He has published widely on all of these issues.

Nikita Strelkovskii holds a master's degree in applied mathematics and computer science and a PhD in mathematics. His research interests include agent-based modeling and simulations, systems thinking, and scenario planning. Dr. Strelkovskii applies his methodological expertise to various applications, from industrial development and infrastructural planning to economic effects of migration, water resources management, and national well-being. He co-developed scenarios of industrial development of Kyrgyzstan in the framework of the IIASA-UNIDO project "Strategy of industrial development of Kyrgyzstan". These scenarios informed the policy recommendations adopted by the Government of Kyrgyzstan. Dr. Strelkovskii also co-designed methodology for qualitative systems analysis application in a participatory context under the IIASA-OECD project

"Providing a training for EU Eastern Partnership officers in strategic planning of water resources and water infrastructure in the context of conflicting stakeholder interests, high risks, and uncertainty, using a participatory approach". He is currently working on developing future scenarios for the Arctic.

Miguel Villoslada is a researcher at the Digital Geosciences group in the University of Eastern Finland. His research focuses on the use of multiple Earth Observation tools to address the complex dimensions of ecosystem structures and functions and assess ecosystem services supply. Currently, his main focus is on shrubification and landcover change processes in the subarctic tundra. He is involved in two ongoing projects: LANDMOD (Academy of Finland), CHARTER (EU H2020). He is also the coordinating the project "Innovative drone-based remote sensing tools for nature conservation" (Proof-of-Concept, Estonian Academy of Sciences).

Ming Xiao is a Professor of Civil Engineering in the Department of Civil and Environmental Engineering at the Pennsylvania State University. His current research focuses on permafrost degradation, permafrost coastal erosion, and their impacts on civil infrastructure and local communities in the Arctic. He has led collaborative and cross-disciplinary research projects funded by the National Science Foundation, Federal Highway Administration, Department of Interior, and state Departments of Transportation to address infrastructure systems' challenges. He is the President-Elect of the U.S. Permafrost Association (USPA), a Fellow of the American Society of Civil Engineers (ASCE), and a Diplomate of Geotechnical Engineering (D.GE) in the ASCE Academy of Geo-Professionals. He currently chairs the USPA Permafrost Engineering Education Program (PEEP) and serves on the Membership Committee of Arctic Research Consortium of the U.S. (ARCUS) and the Frozen Ground Committee of ASCE's Cold Regions Engineering Division.

Henni Ylänne is a post-doctoral researcher working at the School of Forest Sciences at the University of Eastern Finland (UEF). She has a PhD from Oulu University (2017) and has since then conducted research on the impacts of reindeer grazing on the functioning of northern ecosystems with particular interests in ecosystem-atmosphere carbon exchange and soil microbial communities.