

Summary Report

Building a world-leading problem-solving Arctic research center \sim Contribution to the United Nations SDGs centered on field research \sim

February 2025 Arctic Research Center Hokkaido University

Preface

The Arctic is undergoing rapid environmental change and poses a host of environmental, sociocultural, and political-economic challenges for the people living in this region. However, these changes are not limited to the Arctic, and the Asian region is no exception, affecting climate, ecosystems, and human societies in low- and mid-latitude regions. Clarification of and countermeasures against natural and social phenomena observed in various regions due to the rapid changes in the Arctic are urgent global issues that must be resolved, but there are many unresolved problems. It is desirable for researchers, research institutions, and stakeholders who share interests and awareness of issues to cooperate and collaborate across disciplinary boundaries and social sectors to deepen research and solve problems.

To realize the sustainable use of the Arctic, Hokkaido University conducted the HAI-FES project from 2021 to 2025 with the missions of constructing an international collaborative research platform, collaborating with industry-academia-government stakeholders and contributes to the United Nations SDGs and graduate school education.

Researchers with various backgrounds joined the HAI-FES project. This booklet is organized as a summary report consisting of 14 contents showing (i) highlights, (ii) status of collaboration (potential or possible collaborations), (iii) contribution to society (iv) efforts needed in the future and references.



Table of Contents

Preface	
Table of Contents	•••••iii
Air quality monito students	oring and its application to educational and research activities for high school Teppei J. Yasunari ••••••••••••••••••••••••••••••••••••
Study of High- an	d mid-latitude atmospheric environment and climate change Tomonori Sato
Environmental acc	bustics in the Arctic Evgeny A. Podolskiy • • • • • • • • • • • • • • • • • • •
Satellite-Based Ar	ctic Ocean Observatory Capabilities at Hokkaido University Takafumi Hirata
Assessing the imp	acts of future climate and land use changes on traditional food systems Jorge Garcia Molinos • • • • • • • • • • • • • • • • • • •
Post-fire Surface l	Deformation Monitoring at Permafrost Areas using Satellite SAR imageries Masato Furuya ••••••••••••••••••••••••••••••••••••
Research on Arcti	c observation technology using micro-satellites Tsuyoshi Totani •••••••••••••••••••••••••••••••••
Toward safe and e	nvironment-friendly ice navigation Shotaro Uto · · · · · · · · · · · · · · · · · · ·
Examining naviga	tional hazard caused by deformed sea ice along the Northern Sea Route Natsuhiko Otsuka ••••••••••••••••••••••••••••••••••••
Research and Edu	cation on Architecture and Regional Development in Cold Climate Area Taro Mori, Koki Kikuta, Norihiro Watanabe ••••••••21
Investigation of th	e environmental impact of dump sites in small communities in Greenland Yasumasa Tojo, Tatsuya Fukasawa •••••••••••••••••
Energy resource d	evelopment and regional economy in the Russian Arctic Shinichiro Tabata ••••••••••••••••••••••••••••••••••
Digital Infrastruct	ure and green transformation at the Arctic and North Juha Saunavaara
Collaboration and international colla	sharing of best practices between Sámi and Ainu: Tourism, education and boration
	Juha Saunavaara

Arctic Research Cer

Air quality monitoring and its application to educational and research activities for high school students

大気質モニタリングおよび高校生の教育研究活動への応用

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Air quality monitoring and its application to educational and research activities for high school students

Teppei J. Yasunari, Arctic Research Center, Hokkaido University

(i) Highlights

- A low-cost, highly accurate, and multi-location deployable PM_{2.5} measurement system for cold regions was developed (Yasunari et al., 2022).
- We deployed our PM_{2.5} measurement systems in Alaska (Fairbanks) and Japan (<u>Sapporo</u>, <u>Ebetsu</u>, <u>Hakodate</u>, <u>Hirosaki</u>, <u>Nagaoka</u>: in operation) for continuous measurements and in Greenland (<u>Qaanaaq</u>: see Yasunari et al., 2024) for short-term measurements.
- Sometimes, our PM_{2.5} measurement systems detected transboundary smoke transports in Sapporo, which was determined with other supporting data.
- Much effort has been made to make Hokkaido University an air quality observation supersite, including measurements at the roof of ARC for PM_{2.5} (by the measurement system as mentioned above and <u>PurpleAir</u>), black carbon (MA350), and gases (a developed system by Nagoya University in collaboration). Also, the supersite includes long-term aerosol measurements by <u>AERONET</u> (in collaboration with NASA) and a ground-based lidar (in collaboration with NIES), which have been under operation at the Faculty of Engineering.
- The PM_{2.5} measurement system has been installed at <u>Asahigaoka Senior High School</u> (SSH), and the measured PM_{2.5} data have been used for the student's research project as an outreach activity (also see <u>the school's annual report for FY2023</u>). One of the students presented the project outcomes at the high-school student poster session of <u>JpGU Meeting 2024</u> (<u>O08-P52</u>).

(ii) Status of collaboration (potential or possible collaborations)

- Ongoing: NASA (USA), Nagoya University (Japan), NIES (Japan), Ásahigaoka High School (Japan)
- Possible collaboration: IARC/UAF

(iii) Contribution to society

- Our PM_{2.5} measurement system (Yasunari et al., 2022) has been updated and is now <u>commercially available at Tanaka Co., Ltd.</u> in Sapporo. The research group of Kanazawa University obtained and used the commercial one for their research in Mongolia (Batbold et al., 2022). (a contribution to the research community via making the commercial product)
- We provided the high school students with education through research guidance in their research projects (including a presentation at the academic meeting) on observations with our PM_{2.5} measurement system and the data analyses.

(iv) Efforts needed in the future

- Enhancing observation instruments, including collaborations with other research organizations at Hokkaido University's super site and establishing a stable and continuous observation system for transboundary air pollution through long-term observations.
- Contribution to joint research within and outside the research field and to further outreach activities (including more collaborations with high school students) using observation data.

References (also see the websites cited by hyperlinks in the main text)

- <u>Yasunari, T. J.</u>, S. Wakabayashi, Y. Matsumi, and S. Matoba (2022), *J. Environ. Manage.*, 311, 114784. <u>https://doi.org/10.1016/j.jenvman.2022.114784</u>
- Batbold, C., K. Yumimoto, S. Chonokhuu, B. Byambaa, B. Avirmed, S. Ganbat, N. Kaneyasu, Y. Matsumi, <u>T. J. Yasunari</u>, K. Taniguchi, N. Hasebe, K. Fukushi, and A. Matsuki (2022), SOLA, 18, 225–230. <u>https://doi.org/10.2151/sola.2022-036</u>
- <u>Yasunari, T. J.</u>, T. Kajikawa, Y. Matsumi, and K.-M. Kim (2024), *Atmos. Sci. Lett.*, 25(7), e1231. <u>https://doi.org/10.1002/asl.1231</u>

Study of High- and mid-latitude atmospheric environment and climate change

Tomonori Sato, Faculty of Environmental Earth Science, Hokkaido University

Sea surface temperature following to the August heatwave over Siberia



- Heatwaves in northeastern Siberia in August forms warm SST in the Bering Sea which is persistent until October.
- The colder SST is found around Kuroshio extension in September (about onemonth after the heatwave).

Zhou et al. (submitted)

Localized strong warming and humidification over winter Japan tied to sea ice retreat



- Northerly winter monsoon has been substantially warmed and humidified around Japan due to sea ice retreat in the Sea of Okhotsk.
- Pressure patterns that cause stronger regional response to climate change were identified.



Rare bird forecast

- Proposed two methodologies of rare-bird forecast systems through a synergy of arctic seabird monitoring and weather prediction model
- The forecast is expected to contribute to ecosystem conservation and facilitate costeffective wildlife observation by both experts and citizens

Senzaki et al. (2024, Ecology and Evolution)

Enhanced Arctic moisture transport toward Siberia in autumn revealed by tagged moisture transport model experiment



 The transport of atmospheric moisture to Siberia that originated from Arctic Ocean evaporation has increased significantly in autumn to early winter during 1981–2019 when substantial sea ice retreat was observed.

Sato et al. (2022)

Other activities

- Identified the remote impact of Arctic warming in enhancing East Asian precipitation during the Baiu season (Nakamura and Sato, 2022).
- An assessment of the costs associated with the Sapporo Snow Festival in light of future global warming.

Study of High- and mid-latitude atmospheric environment and climate change

Tomonori Sato, Faculty of Environmental Earth Science, Hokkaido University

(i) Highlights

- Heatwaves in northeastern Siberia in August forms warm SST in the Bering Sea which is persistent until October. The colder SST is found around Kuroshio extension in September (about one-month after the heatwave). (Zhou et al. 2024, in revision)
- Proposed two methodologies of rare-bird forecast using arctic seabird monitoring and weather prediction model. The forecast is expected to contribute to ecosystem conservation and facilitate cost-effective wildlife observation by both experts and citizens. (Senzaki et al., 2024)
- Northerly winter monsoon has been substantially warmed and humidified around Japan due to sea ice retreat in the upwind sea. Pressure patterns that cause stronger regional response to climate change were identified. (Tamura and Sato, 2023)
- The transport of atmospheric moisture to Siberia that originated from Arctic Ocean evaporation has increased significantly in autumn to early winter during 1981–2019 when substantial sea ice retreat was observed. (Sato et al., 2022)

(ii)Status of collaboration (potential or possible collaborations)

- Collaboration with sea birds migration research community.
- Collaboration with hydrologist and geographer.

(iii) Contribution to society

- The forecast contributes to ecosystem conservation and facilitates cost-effective wildlife observation by both experts and citizens.
- The discovery of weather pattern-dependent climate change can be applied to the assessment of historical extreme weather events, determining whether they were linked to climate change.
- The importance of monitoring equatorward moisture transport during snow accumulation seasons was suggested because it could enhance local snowstorms as evaporation from the Arctic Ocean increases in the near future.
- An assessment of the costs associated with the Sapporo Snow Festival in light of future global warming indicates that the costs could potentially double.

(iv) **Efforts needed in the future**

• Application of above outcomes to realtime forecast from daily to seasonal timescales.

- Zhou, X., Li, S., and <u>T. Sato</u>, Different Atmospheric Circulation Patterns Relating to Heatwaves over Northeastern Siberia in July and August, in revision.
- Senzaki, M., K. Tamura, Y. Watanabe, M. Watanabe, and <u>T. Sato</u>, 2024: Rare bird forecast: a combined approach using a long-term dataset of an arctic seabird and a numerical weather prediction model, *Ecology and Evolution*, 14, e11388, DOI:10.1002/ece3.11388,
- Tamura, K. and <u>T. Sato</u>, 2023: Localized strong warming and humidification over winter Japan tied to sea ice retreat, *Geophys. Res. Lett.*, 50, e2023GL103522, DOI:10.1029/2023GL103522
- <u>Sato, T.,</u> T. Nakamura, Y. Iijima, and T. Hiyama, 2022: Enhanced Arctic moisture transport toward Siberia in autumn revealed by tagged moisture transport model experiment, *npj Climate and Atmospheric Science*, DOI: 10.1038/s41612-022-00310-1
- Tamura, K. and <u>T. Sato</u>, Evaluating how historical climate change affected a heavy snowfall event in northern Japan in mid-December 2021 using two pseudo global warming methods, in revision.
- Nakamura, T., and <u>T. Sato</u>, 2022: A Possible Linkage of Eurasian Heat Wave and East Asian Heavy Rainfall in Relation to the Rapid Arctic Warming. *Env. Res.*, 209, 112881, DOI:10.1016/j.envres.2022.112881

Environmental acoustics in the Arctic

Evgeny Podolskiy, Arctic Research Center, Hokkaido University

METHODS

acoustic monitoring of socially important environmental issues (subsistence animals and glaciers in Greenland), supported by other *in situ* methods (e.g., biologging)





Environmental acoustics in the Arctic

Evgeny A. Podolskiy, Arctic Research Center, Hokkaido University

(i) Highlights

- We conducted acoustic monitoring of socially important environmental subjects (e.g., subsistence animals, like whales and birds, and rapidly changing glaciers in Greenland).
- Studies on sound in the Arctic ocean (e.g., Podolskiy et al. *SRL*, 2021), and on land (e.g., Podolskiy et al. *GRL*, 2023), supported by other *in situ* methods, are scientifically insightful and allow understanding of hidden animal behaviour and various phenomena.

(ii) Status of collaboration (potential or possible collaborations)

Within HU, I continued collaboration with Prof. S. Sugiyama (ILTS), graduate students T. Imazu and M. Ogawa (Graduate School of Environmental Science), Assist. Prof. J.-B. Thiebot (Graduate School of Fisheries Sciences), and Yoshio Murai (Institute of Seismology and Volcanology). Externally, I also established collaboration with danish Aarhus University and Greenland Institute of Natural Resources (K. L. Johansen, A. Mosbech, J. Teilmann, M. P. Heide-Jørgensen). We also continued our collaboration with Inuit hunters in Greenland.

(iii) Contribution to society

Sharing new knowledge was my main contribution to society. For outreach and dissemination of results, I was invited to write popular articles (see below: Eos 2021a, Eos 2021b, The Circle, 2023), replied to journalists, leading to a substantial media coverage of my work in Japan (e.g., Nikkei) and abroad (e.g., Nature), and contributed acoustic data to exhibitions in France and China (https://www.citedelamer.com/espaces/ocean-sur-ecoute/, Jockey Club Museum of Climate Change, The Chinese University of Hong Kong).

(iv)Efforts needed in the future

• Sustained long-term observations are key for detecting changes; we hope to continue such.

- <u>Synchronization of bowhead whales</u>, Podolskiy, E.A. J. Teilmann, M. P. Heide-Jørgensen Physical Rev. Res., XP10736W (003000) 2024/08/15 [Refereed]
- <u>Acoustic monitoring reveals a diel rhythm of an arctic seabird colony (little auk, Alle alle)</u> Podolskiy, E.A., M. Ogawa, J.-B. Thiebot, K. L. Johansen, A. Mosbech, Communications Biology 7 (307) 2024/03/15 [Refereed].
- <u>Acoustic sensing of glacial discharge in Greenland</u>, Podolskiy, E.A., T. Imazu, S. Sugiyama, Geophysical Research Letters 50 (e2023GL103235) 2023/04 [Refereed].
- <u>WHAT THE SOUNDS OF ICEBERG CALVING CAN TELL US</u>, Podolskiy E.A The Circle (WWF) 4 14 - 17 2023/01 [Not refereed][Invited]
- <u>Strange attractor of a narwhal (Monodon monoceros)</u>, Podolskiy, E.A. and M. P. Heide-Jørgensen, PLOS Comput. Biology, 18 (9) e1010432 - e1010432 2022/09/22 [Refereed]
- <u>Glacial earthquake-generating iceberg calving in a narwhal summering ground: The loudest</u> <u>underwater sound in the Arctic?</u> Podolskiy, E. A., Y. Murai, N. Kanna, S. Sugiyama, JASA, 151(1) 6-16, 2022/01/03 [Refereed]
- <u>Arctic unicorns and the secret sounds of a glacial fjord</u>, Podolskiy, E., EOS, 102, 2021/12/09 [Not refereed][Invited]
- <u>Undertaking adventure to make sense of subglacial plumes</u>, Podolskiy, E., EOS 102, 2021/08/19 [Not refereed][Invited]
- <u>Ocean-bottom and surface seismometers reveal continuous glacial tremor and slip</u>, Podolskiy, E., Y. Murai, N. Kanna, S. Sugiyama, Nat. Comm. 12(1) 3929 2021/06/24 [Refereed]
- Ocean-Bottom Seismology of Glacial Earthquakes: The Concept, Lessons Learned, and Mind the Sediments, Podolskiy, E. A., Y. Murai, N. Kanna, S. Sugiyama, SRL, 92 (5) 1 -16, 2021/05/05 [Refereed]

Satellite-Based Arctic Ocean Observatory Capabilities at Hokkaido University

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Satellite-Based Arctic Ocean Observatory Capabilities at Hokkaido University

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(i) Highlights

- Achieved the in-house earth observation station capabilities within Hokkaido University for the micro-satellite RISESAT manufactured by the University
- Realized the satellite ocean remote sensing for the Arctic Ocean and Hokkaido waters with scientific quality via the self-contained satellite data processing.

(ii) Status of collaboration (potential or possible collaborations)

- Co-Authored an international report through the joint group of the inter-governmental bodies such as the North Pacific Science Organization (PICES), International Council for the Exploration of the Sea (ICES), and Protection of the Arctic Marine Environment group of the Arctic Council (PAME)
- Collaborated internationally with the north European nations in the Horizon 2020 program
- Contracted a joint research with a commercial industry company
- Contracted a join research with the Japanese space agency
- Collaboration across Hokkaido University (e.g. School of Science, Field Science Center for Northern Biosphere, Faculty of Engineering, Space Mission Center)

(iii) Contribution to society

- Policy Making: Engaged as a comittee member in the carbon-neutral policy development of Tobetsu Town, Hokkaido, Japan
- Outreach: Hosted public lectures with a local Board of Education under the human resource development project of Tobetsu Town, Hokkaido, Japan

(iv) Efforts needed in the future

• Systemizing and generalizing remote sensing application platform for public/commercial services and for policy making in the Arctic and Hokkaido

- Masuda, Y., Yamanaka, Y., Smith, S.L, <u>Hirata, T.</u>, Nakano, H., Oka, A., Sumata, H., Noguchi Aita, Acclimation by diverse phytoplankton species determines oceanic carbon to nitrogen ratios, Limnology and Oceanography Letters (2023)
- Alabia, I.D., García Molinos, J., <u>Hirata, T.</u>, Mueter, F.J., David, C.L., Pan-Arctic marine biodiversity and species co-occurrence patterns under recent climate, Scientific Reports, 13(1),DOI:10.1038/s41598-023-30943-y (2023)
- Bracher, A., Brewin, R.J.W., Ciotti, A.M., Clementson, L.A., <u>Hirata, T.</u>, Kostadinov, T., MOuw, C.B. and Organelli, E., Applications of satellite remote sensing technology to analysis of phytoplankton community structure on large scales, In *Advances in Phytoplankton Ecology*, First Edition, Elsevier, ISBN:9780128228616 (2022)
- Acquarone, M., Berkman, P.A., Bluhm, B., Christensen, T., Dupluis, A., Edelvang, K., Flores, H., Frie, A.K., Gavrillo, M.,
 Gjosaeter, H., Gremeier, J., Einar, B., Hedges, K., van den Heuvel-Greve, M., <u>Hirata, T.</u>, Hoel, A.H., Hop, H., Ingvaldsen,
 R., Jorgensen, L.L., Luletz, K., Leijonmalm, P.S., Mosbech, A., Nilsson, J., Nishino, S., Ohnishi, F., Otsuka, N., <u>Saitoh, S.,</u>
 Speer, L., Skern-Mauritzen, M., von Quillfeldt, C. ICES/PICES/PAME working group on integrated ecosystem assessment
 (IEA) for the central Arctic Ocean, ICES Scientific Reports, 4:6, http://doi.org/10.17895/ices.pub.9766 (2022).
- Hirata, T. and Suzuki, K. Relative contributions of photophysiology and chlorophyll-a abundance to phytoplankton group-specific primary production in the Kuroshio region as inferred by satellite ocean color remote sensing, Journal of Oceanography, https://doi.org/10.1007/s10872-022-00638-5 (2022)
- Imai, M., <u>Kurihara, J.</u>, Kouyama, T., Kuwahara, T., Fujita, S., Sakamoto, Y., Sato, Y., <u>Saitoh, S.-I., Hirata, T.</u>, Yamamoto, H., <u>Takahashi, Y.</u>, Radiometric Calibration for a Multispectral Sensor Onboard RISESAT Microsatellite Based on Lunar Observations, Sensors, 21, 2429, doi:10.3390/s21072429, (2021)



- Projecting the effects of future climate and land use change on the distribution of wild food species.
- Exploring perceptions of communities on climate change, the type of impacts they have experienced, and their adaptation capacity.

Outreach & capacity building

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- Inclusive approach and capacity building (local teams of collaborators, field training, regular consultation and feedback to the communities).
- Active engagement of early career members (field work, research visits, scientific output).
- Promoting understanding and cooperation through discussion between communities and government institutions on controversial issues (land rights, natural resource use, climate change impacts) of common interest.

Study protocol: International joint research project 'climate change resilience of

Indigenous socioecological systems' (RISE)

Varvara Parilova⁶, Sol Yakovleva⁹, Prapa Kor Wantare





Journal of Environmental Management Volume Set, IS Colorby 2011, 19548

Free prior informed consent in the extractive industry: Approaches to involving Indigenous peoples in decision-making in



Navigating Legal and Regulatory Frameworks to Achieve the Resilience and Sustainability of Indigenous Socioecological Systems Super Libron Margue 1, Jone Cana Malens 19, News Pathers 19, Jones Farlers 19, Jones Farlers 19, Jones Pathers 19, Jones Farlers 19, Jones 19, Jones 19, Jones 19, Jones 19, Jones 19, Jones 19,

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PLOS ONE

Assessing the impacts of future climate and land use changes on traditional food systems

Jorge García Molinos, Arctic Research Center, Hokkaido University

(i) Highlights

- Research conducted under international joint research project (JGM lead PI) "climate change Resilience of Indigenous SocioEcological systems (RISE)" (04.2021-03.2024) funded by the JST-eASIA program.
- The project involved the participation of research teams from Japan, Russia and Thailand.
- Complementary expertise and multidisciplinar teams: ecology, anthropology, sociology, economics, nutritional and health sciences.
- Two contrasting case studies with different climatic, environmental, regulatory and socioeconomic challenges: indigenous communities of the Sakha Republic (Russian Far East) and two Karen communities in Thailand.
- Objective: understanding the importance of traditional food systems (TFS) in supporting the livelihoods and well-being of rural indigenous communities and how they can be affected by present and future environmental changes, particularly driven by climate change.
- Our comparative study offers valuable insights into the complex interplay between socioeconomic, nutritional, legal and regulatory frameworks, and climate/environmental changes in shaping the resilience and sustainability of Indigenous socioecological systems.
- Contribution to management and policy: the project successfully brought together representatives of the indigenous communities, local authorities, and regional institutions providing a forum for discussion on conflicting issues of common interest (food security, climate change, land rights, resource use...). This resulted in expressions of intent to develop more inclusive co-management practices and regulatory frameworks that better recognize the rights and needs of indigenous communities.
- Community engagement & outreach: the project promoted the active participation of local indigenous community members in the research project, particularly young members, as well as early career researchers from the participating countries (see Contribution to society).
- More information on the project participants, activities, and results (including the project synthesis report) can be consulted at <u>https://jorgegmolinos.wixsite.com/rise</u>

(ii) Status of collaboration (potential or possible collaborations)

- The project involved the participation of over 20 researchers from multiple research, academic, and governmental institutions from Japan, Russia and Thailand.
- Collaboration among teams is ongoing to complete the publication of results from the project.
- The teams are also considering future collaboration building on the outputs from this project.

(iii) Contribution to society

- The project was committed to make inclusive and accessible science that feedback to the communities we worked with.
- Workshops were held regularly to inform the communities and other relevant stakeholders about the research and get their comments and input.
- Members of the study communities played a major role in the project. Other than the open participation of community members in the project workshops, local teams of collaborators actively contributed to the collection of field data, the planning and discussion of project activities, and the organization of local workshops for the communities. Their active participation allowed them to gain a deep understanding of the research methods (field training sessions were organized for them) and the scientific component of the project, making them key liaisons in the day-to-day communication between the communities and our research teams.
- Community members who volunteer for the anthropometric and biochemical health assessments conducted for the project received the results from their analyses and advice by

health professionals on any health condition or dietary issue that were detected. This was a rare and very welcome opportunity for them since these analyses and professional advice are usually either not available or too expensive for them to have access to.

• Promotion of early careers and young researchers through their active involvement in all stages of the project: planning, fieldwork, analysis of results, and co-production of deliverables. Research stays were organized for them among the institutions of the three participating countries, including stays for training purposes.

(iv) Efforts needed in the future

• Although exceptional external circumstances such as the COVID-19 pandemic or the war in Ukraine severely limited the project development as initially planned, the project still generated new valuable knowledge and a wealth of relevant data that we hope will lead to future work and collaboration among the communities, research institutions, funding agencies, and governmental bodies. To achieve long-term goals, future research and funding investment should be directed towards supporting the indigenous communities by funding local projects managed by the local communities.

- García Molinos, J., T. Gavrilyeva, P. Joompa, D. Narita, S. Chotiboriboon, V. Parilova, S. Sirisai, I. Okhlopkov, Z. Zhang, N. Yakovleva, P. Kongpunya, S. Gowachirapant, V. Gabyshev, W. Kriengsinyos . 2022. Study protocol: International joint research project 'climate change resilience of Indigenous socioecological systems' (RISE). PLOS ONE, 17(7): e0271792 https://doi.org/10.1371/journal.pone.0271792
- García Molinos, J., D. Yamada, V. D. Parilova, S. Khasanov, V. Gabyshev, A. Makarov, D. Narita, I. Okhlopkov, Z. Zhang, S. C. Sakapaji, T. N. Gavrilyeva. In review. Future climate and land use changes challenge current dependencies on wild food harvesting by rural Indigenous communities. PNAS Nexus.
- Narita, D., S. Kasanov, V. D. Parvilova, T. N. Gavrilyeva, J. García Molinos, S. C. Sakapaji. In review. 第9章:成田大樹(東京大学)「気候変動影響:特に家計と食に関して」In ロシア北極域経済の変動:サハ共和国を事例として」. 田畑伸一郎 (Ed.). 北海道大 学出版会.
- Sakapaji, S.C., J. García Molinos, V. Parilova, T. Gavrilyeva, N. Yakovleva. 2024. Navigating legal and regulatory frameworks to achieve the climate resilience and sustainability of indigenous socioecological systems. Resources, 13(4): 56 https://doi.org/10.3390/resources13040056

Post-fire Surface Deformation Monitoring at Permafrost Areas using Satellite SAR imageries

衛星SAR画像による凍土帯の火災後地盤変動モニタリング

Masato Furuya, Faculty of Science/ARC

Quantification of the post-fire "irreversible" ground subsidence by SAR remote sensing techniques at Batagay, NE Siberia and Northwest Territories, Canada



(b)Further fires in 2018 and 2019; updated Cumulative Displacements (2020/08/28-2024/01/26)



Slant-range changes are mostly due to the vertical



Yanagiya and Furuya (2020, JGR-ES) Yanagiya et al (2023, JGR-ES)

(c)Northwest Territories in Canada (Cao and Furuya, 2024, ERL)



(d)Wildfires in 2019 and 2021 Processed Sentinel-1A SAR images (2019.01.09 to 2024.01.06) No deceleration signs even



Post-fire Surface Deformation Monitoring at Permafrost Areas using Satellite SAR imageries

Masato Furuya, Faculty of Science/ARC, Hokkaido University

(i) Highlights

- Post-wildfire surface deformation on the northwest of Batagay, Eastern Siberia, was detected by two independent Interferometric Synthetic Aperture Radar (InSAR) systems. Spatial heterogeneities of the subsidence magnitude were clearly correlated to the gully development, whereas the burn severity was rather homogeneous. Detection of enhanced uplift signals at the fire scar and its interpretation based on a physics-based frost heave theory. (Yanagiya and Furuya, 2020)
- Transient post-fire deformations at the 2018 and two 2019 scars near Batagay were examined by satellite radar and onsite thaw depth data. The northern 2019 scar subsided by 13 cm in the first span-fire year, but the other two scars uplifted and started to subside during the next year. The duration of frost heave is longer in the next year after fire than in the burned year because of more soil water in the active layer (Yanagiya et al., 2023)
- Using the time-series analysis of Sentinel-1 InSAR, we examined the surface deformation after the 2019 fire in the lower Mackenzie Valley, Northwest Territories, Canada, where dramatic heat anomalies and severe wildfires have been recorded in recent years. Even four years after the fire, the subsidence rates are increasing year-by-year. The cumulative subsidence was detected up to 25 cm in the line-of-sight direction in the upland areas and up to 10 cm in the lowland areas (Cao and Furuya, 2024).

(ii) Status of collaboration (potential or possible collaborations)

- Go Iwahana (ARC/Alaska Univ.)
- Kazuki Yanagiya (JAXA EORC)
- Melnikov Permafrost Institute (Russian Academy of Science), Northeastern Federal University (Russia), Tongji University (China)

(iii) Contribution to society.

● NHK BS スペシャル デジタルアイ「消える大森林」(R6.1.15 取材、R6.4.11 放送) https://www2.sci.hokudai.ac.jp/faculty/information/10062

(iv) Efforts needed in the future

- Yanagiya, K., and Furuya, M. (2020): Post-wildfire surface deformation near Batagay, Eastern Siberia, detected by L-band and C-band InSAR, J. Geophys. Res. Earth Surface, 10.1029/2019JF005473
- K. Yanagiya, M. Furuya, P. Danilov, G. Iwahana 2023 Transient Freeze-Thaw Deformation Responses to the 2018 and 2019 Fires Near Batagaika Megaslump, Northeast Siberia. J. Geophys. Res. Earth Surface, 128(2), <u>https://doi.org/10.1029/2022JF006817</u>
- Cao, Z., and Furuya, M. (2024), No Deceleration Signs in the Permafrost Ground Subsidence Four Years after the 2019 Fire in Northwest Territories, Canada., Environ. Res. Lett., DOI 10.1088/1748-9326/ad7871

Research on Arctic observation technology using micro-satellites Tsuyoshi Totani, Naoki Aoyama, Kazuki Kawai, Yuji Sakamoto



- Tsuyoshi Totani, Kazuki Kawai, Naoki Aoyama and Yuji Sakamoto, Feasibility of Observation Methods for Turbulent Ice Areas using Nano- and Micro-satellites, Proceedings of the 68th Space Sciences and Technology Conference, 2K18, 2024.
- Kazuki Kawai, Tsuyoshi Totani and Yuji Sakamoto, Sensor Development for Microsatellites to Observe Turbulent Ice Area, Proceedings of the 66th Space Sciences and Technology Conference, 3H21, 2022.

Research on Arctic observation technology using micro-satellites

Tsuyoshi Totani, Naoki Aoyama, Kazuki Kawai, Yuji Sakamoto, Faculty of Engineering, Hokkaido University

(i)Highlights

- It is possible to distinguish sea ice from sea water using reflected waves from GNSS signals.
- Potential usage of Northern Sea Route is increasing with retreat of crosphere in global climate change.
- Turbulent ice areas along the NSR remain even in summer.
- Early warning for turbulent ice is a key for a safety in ship navigation.
- Micro-satellites with GNSS receivers can tie up for the turbulent ice observation.

(ii) Status of collaboration (potential or possible collaborations)

• None.

(iii) Contribution to society

• Early warning for turbulent ices in ship navigation

(iv) Efforts needed in the future

- Ground demonstration test using signals from GNSS satellites
- Demonstration test using a microsatellite
- Establishment of the early warning system
- Establishment of automatic data collection, processing, and publication system

- Tsuyoshi Totani, Kazuki Kawai, Naoki Aoyama and Yuji Sakamoto, Feasibility of Observation Methods for Turbulent Ice Areas using Nano- and Micro-satellites, Proceedings of the 68th Space Sciences and Technology Conference, 2K18, 2024.
- Kazuki Kawai, Tsuyoshi Totani and Yuji Sakamoto, Sensor Development for Microsatellites to Observe Turbulent Ice Area, Proceedings of the 66th Space Sciences and Technology Conference, 3H21, 2022.

Toward safe and environment-friendly arctic navigation

Shotaro Uto, Arctic Research Center, Hokkaido University

Background

Arctic sea ice has been decreasing rapidly and commercial use of the Arctic Shipping Routes has been expanding in recent years. However, sea ice is still a serious hazard for arctic navigation especially for a large merchant vessel with low ice class (Otsuka and Uto, 2024). It requires the special consideration for safer and environment-friendly navigation and toward the sustainable use of the Arctic Shipping Routes.

Safety Assessment and IMO POLARIS

IMO (International Maritime Organization) proposed the guidance on methodologies for assessing operational capabilities and limitation in ice (IMO, 2016). This guideline includes the Polar Operational Limit Assessment Risk Indexing System (POLARIS), which is based on an evaluation of the risks posed to the ship by ice conditions in relation to the ship's assigned ice class. However, POLARIS does not provide operational capabilities which is determined by the hull form and machinery of each vessel.

Operational Capability in Ice

The author developed the method for predicting operational capability (resistance and required power) in an ice regime using ice chart information (Uto et al. 2023, Uto et al. 2024a).



Fig.1 Validation-1@Sea of Okhotsk

The Ice trial on board icebreaker Soya of Japan Coast Guard was conducted in the marginal ice zone of the Sea of Okhotsk in February 2011. Power and ship speed were measured by strain gauges and GPS, respectively. Using the results of onboard visual observation of sea ice, the power curve (power vs. ship speed) is predicted by the theoretical model. The symbol shows the measured power. Full and dashed line shows the predicted power curve in each ice regime and in ice-free water, respectively.

A New Framework of Navigability Assessment

The author defines "Navigability" as safety and operational capability in ice navigation and proposed the framework of the navigability assessment of iceclass vessels by extending POLARIS with the function for evaluating operational capability in ice (Uto et al., 2023).

The Japanese Arctic Research vessel "Mirai II" will be used as a platform for future technological validation toward contribution to the vessel's operational planning and safe and environmentalfriendly operation in the future.



Fig.2 Validation-2@Kara Sea

The target vessel is an icebreaking cargo vessel with a length of 299 m and a main engine power of 45 MW, operating in the Kara Sea. Ice charts were used for ice condition information. .The broken line indicates the speeds by satellite AIS. Using the present method, we predicted the power-speed relations in each ice regime and obtained the ship's speed at normal setting by straight lines.



Fig 3 A proposed extended framework of POLARIS

Newly added functions are circled with red lines.

References

IMO, (2016): Guidance on methodologies for assessing operational capabilities and limitations in ice. MSC.1/Circ.1519 Otsuka N. Et al. (2023): Navigational hazard by sea ice convergence in the North East Passage. Arctic Frontiers, Tromso, Norway. Uto S. et al. (2023): Navigability assessment of ships in ice using ice chart information. Proc. POAC. Glasgow UK. Uto S. et al. (2024a): Formulation and validation of resistance prediction scheme for ships in ice regime described in WMO egg code. Article 104159. Vol.221. Cold Regions Science and Technology. Uto S. et al. (2024b): Validation of powering method of ships in ice using Satellite AIS information. Proc. IAHR Ice Symp.

Toward safe and environment-friendly ice navigation

Shotaro Uto, Arctic Research Center, Hokkaido University

(i) Highlights

- Define "Navigability" as safety and operational capability in ice navigation.
- Propose the new framework of the navigability assessment of ice-class vessels by extending IMO POLARIS with the function for evaluating operational capability in an ice regime.
- Develop new scheme for evaluating operational capability in an ice regime using WMO egg code information.
- Conduct technical validation study of the new function using the field data in the Sea of Okhotsk and the satellite AIS data in Kara Sea in the Russian Arctic, showing the validity of the proposed scheme.

(ii) Status of collaboration (potential or possible collaborations)

- Japan Consortium for Arctic environmental Research (JCAR): Discussions at the ice engineering working group.
- Industries: Collaborative research on the ice engineering research.
- JAMSTEC: Discussion on the utilization of the Arctic research vessel "MIRAI II".
- JASNAOE: Special session of the ice engineering research at the annual meeting.

(iii) Contribution to society

- Contribute to the planning and operation of safe and environment-friendly voyage of the Japanese Arctic Research Vessel MIRAI II
- Propose International Maritime Organization (IMO) for the amendment of the interim guidance on methodologies for assessing operational capabilities and limitations in ice. MSC.1/Circ.1519

(iv) Efforts needed in the future

• Comprehensive validation study of the proposed scheme using measured ship data in the Arctic Sea utilizing the Arctic Seas Japanese Arctic Research Vessel MIRAI II as a platform of validation study.

- Otsuka N. Snd Uto S. (2023): Navigational hazard by sea ice convergence in the North East Passage. Abstracts for NIPR Symposium on Polar Science.
- Uto S., Matsuzawa T., Izumiyama K., Otsuka N. (2023): Navigability assessment of ships in ice using ice chart information. Proc. 27th POAC12-16 June 2023 Glasgow, UK.
- Uto S., Matsuzawa T., Shimada H., Wako D., Toyota T. (2024a): Formulation and validation of resistance prediction scheme for ships in ice regime described in WMO egg code. Cold Regions Science and Technology. Vol. 221, Article 104159.
- Uto S. andOtsuka N. (2024b): Validation of powering method of ships in ice using Satellite AIS information. Proc. IAHR International Symposium on Ice.

Examining navigational hazard caused by deformed sea ice along the Northern Sea Route

Natsuhiko Otsuka, Arctic Research Center, Hokkaido University

Introduction

The Arctic sea ice is retreating and more calm condition is expected so that the navigable season will expand and commercial utilization will become reality in the near future. Since 2010, the Northern Sea Route, which connects the Atlantic and Pacific Ocean along the Russian Arctic coast, has been drawing attention for natural resource development and maritime transport between Europe and Asia. However, still there is a risk and uncertainty in navigation of the Arctic Ocean. This study examines navigational hazard caused by sea ice in the Arctic Ocean and try to find a parameter to evaluate navigational hazard by sea ice.



Examining navigational hazard caused by deformed sea ice along the Northern Sea Route

Natsuhiko Otsuka, Arctic Research Center, Hokkaido University

(i) Highlights:

- Examine actual ship stucking incidents along the Northern Sea Route such as ship track, ship speed, ice condition, and icebreaker rescue operation.
- Sea ice condition was retrieved from satellite observation by microwave radiometer and synthetic aperture radar, data assimilation model, and ice chart provided by Russia.
- Proposing ice convergence parameter by sea ice volume flux, actual ship stucking incidents were examined. This parameter has a possibility to examine navigational hazard caused by accumulating sea ice behavior together with the risk index, which is introduced by International Maritime Organization(IMO).

(ii) Status of collaboration (potential or possible collaborations)

- This result is shared with shipping company and ship building company through the Japan Consortium for Arctic Environmental Research(JCAR) working group.
- Introducing the results to the Next Stage Logistics research Group(Waseda Univ.).
- Further collabboration with logistic company to evaluate the feasibility of Arctic shipping is expected.
- Environmental assessment of Arctic shipping and research on sustainable use of Arctic Ocean is expected.

(iii) Contribution to society

- Examination of navigational risk could have a possibility to contribute policy makers to discuss maritime policy and utilization/consevation of the Arctic Ocean.
- Future results could be shared with the Arctic Council Working Group(PAME/Shipping Expert Group).

(iv) Efforts needed in the future

- Efforts to evaluate more detailed sea ice condition and further analysis about sea ice condition, ship ability(ice class), risk parameter and navigational hazard is needed.
- Future results could be shared with the Arctic Council Working Group(PAME/Shipping Expert Group).

- Otsuka N. and Uto S. (2023): Navigational hazard by sea ice convergence in the North East Passage. Abstracts for NIPR Symposium on Polar Science.
- Otsuka N. (2024): Navigational hazard by sea ice convergence in the North East Passage. Poster for the Arctic Frontiers 2024.
- Otsuka N. and Uto, S. (2024): Investigation of Beset Incidents in the Northern Sea Route by Risk Index and sea ice convergence. The 38th International Symposium on the Okhotsk Sea & Polar Oceans.

1. Research on Building Energy Efficiency in remote Cold Regions

Taro Mori, Hisato Osawa, Yumi Nakano Graduate School of Engineering, Hokkaido University

1.1) Regional Development and IEQ of Greenlandic house





Heating energy simulation and solar panel power generation simulation were conducted using an analytical model created by 3D surveying at the site Osawa, Oike, Mori, Improving the Sustainability of Remote Arctic Communities with High-Energy-Efficiency Houses, Polar Science 101101-101101 2024/7

1.2) Building Energy Simulation in Cold Region with GIS data







The air conditioning loads of 3,000 office buildings in Sapporo were calculated using a simulation model automatically generated from GIS.

This method will be used for energy simulation of small municipalities in cold climates. This project is supported by NEDO. https://www.nedo.go.jp/content/100981665.p df

1.3) Insulation Retrofit of Wooden Apartment Building



Before the retrofit, the apartments showed deterioration caused by rotting fungi. The apartment was dismantled to its skeleton state and the insulation was replaced. After the renovation, airtightness was measured. Heating and cooling energy simulation results showed that the heating and cooling energy could be reduced by half by improving the insulation performance. This project is supported by MILT. https://www.mlit.go.jp/jutakukentiku/house /content/001744178.pdf

Research and Education on Architecture and Regional Development in Cold Climate Area Taro Mori, Koki Kikuta, Norihiro Watanabe, Faculty of Engineering

(i)Highlights:

1. Research on Building Energy Efficiency in Remote Cold Regions

- 1.1) Regional development and Indoor Environment Quality (IEQ) of houses in remote towns in Greenland.
- Heating energy and solar panel power generation simulations were conducted using an analytical model created by 3D surveying and year-round IEQ measurements of a local building at the site. Osawa Hisato, Satoshi Oike, Taro Mori, "Improving the Sustainability of Remote Arctic Communities with High-Energy-Efficiency Houses", Polar Science, 101101-101101 2024/7

1.2) Building energy simulation in cold regions with GIS data. Automatically creates a model for air-conditioning energy simulation from the map information.

- Calculating air conditioning energy for the remote cold areas. Osawa Hisato, Taro Mori, Kouichi Shinagawa, Satoshi Nakayama, Hayato Hosobuchi, Emad Mushtaha, "Analysis of Requirements for Achieving Carbon Neutrality in a Cold Dense City Using GIS", Energies 15(19) 7063-7063 2022/9/26. NEDO has issued a public call for "Technological development for the construction of a system to utilize renewable energy heat" and our group has been selected. https://www.nedo.go.jp/content/100981665.pdf
- 1.3) Insulation retrofit project for a wooden apartment building.
- Our project was selected for the Ministry of Land, Infrastructure, Transport and Tourism's 2024 Housing Stock Maintenance and Improvement Promotion Project. https://www.mlit.go.jp/jutakukentiku/house/content/001744178.pdf

1.4) Influence of IEQ on residents' health. Relationship between energy-saving categories and seasonal mortality from 1972 to 2015.

- The multivariate analysis suggested that mortality rates were more likely to increase in winter in warmer regions. Appropriate heating of residential houses is important.
- 2. Environmental Architecture in cold regions
- 2.1) Environmental design of an office:
- Based on a case study of FM center in Sapporo, ABW (Activity Based Working) was designed through the construction of semi-outdoor spaces and the spread of wood construction in non-residential buildings was targeted. Low carbon emissions and a smart wellness office that combines natural ventilation and radiant air conditioning using abundant groundwater as a heat source were realized, and this case has won many awards. https://www.takenaka.co.jp/majorworks/10050142021.html
- 2.2) Air quality control in an ice arena:
- This is a representative case of suspected transmission through the air in Japan. The factors that led to the spread of infection from players to spectators were elucidated. New ventilation measures were proposed and developed into guidelines for infection control in Asian ice hockey. https://www.niid.go.jp/niid/ja/2019-ncov/2488-idsc/iasr-news/11159-508p03.html. https://doi.org/10.3390/buildings14061632
- 3. Urban design in cold regions
- 3.1) Urban and architectural design using wind and snow simulation:
- Using CFD (Computational Fluid Dynamics) to simulate snow, we analyzed the relationship between the shape of skyscrapers in the center of Sapporo and the amount of snow that accumulates on them. <u>https://www.aij.or.jp/paper/detail.html?productId=687349</u>

3.2) Public space design based on analysis of human behavior by various weather condition in cold region:

• We analyzed the relationship between the outdoor environment (temperature and snowfall) and human behavior in the AKAPLA Plaza in Sapporo City, and clarified the design policy

2. Environmental Architecture in Cold Region

Koki Kikuta, Faculty of Engineering

2.1) Environmental design of an office



Based on a case study of FM center in Sapporo, ABW (Activity Based Working) was designed through the construction of semi-outdoor spaces and the spread of wood construction in nonresidential buildings was targeted.

Low carbon emissions and a smart wellness office that combines natural ventilation and radiant air conditioning using abundant groundwater as a heat source were realized, and this case has won many awards.

https://www.takenaka.co.jp/majorworks/ 10050142021.html

2.2) Air quality control in an ice arena



Positive rates by location among spectators



Games by professional players (Ventilation frequency)



Ventilation measures (particle concentration)

This is a representative case of suspected transmission through the air in Japan.

The factors that led to the spread of infection from players to spectators were elucidated. New ventilation measures were proposed and developed into guidelines for infection control in Asian ice hockey.

https://www.niid.go.jp/niid/ja/2019-ncov/2488idsc/iasr-news/11159-508p03.html

Koki Kikuta, Shun Omori, Masakazu Takagaki, Yasuhiko Ishii, Kazuhiro Okubo, Yuta Ohno, Yoshihiro Fujiya, Hitomi Kurosu, Tomoe Shimada, Tomimasa Sunagawa, Takuya Yamagishi, Motoya Hayashi: Verification of Ventilation and Aerosol Diffusion Characteristics on COVID-19 Transmission through the Air Occurred at an Ice Arena in Japan, Buildings, Vol 14 No.6, 1632, 2024.6.2 https://doi.org/10.3390/buildings14061632

- to promote the use of public spaces in winter. Norihiro Watanabe, Tsuyoshi Setoguchi, "A Study of the Relationship between Human Behavior and Urban Design during the Winter in a High-Snowfall Urban Area", Sustainability, 16(10), 3983, 2024
- 3.3) Public space design in cold regions based on analysis of human emotions using SNS:
- By analyzing photos posted on social media of Lenin Square in Khabarovsk, Russia during the winter, we identified a temporary design that improves people's emotions. Anastasiia A. Paukaeva, Tsuyoshi Setoguchi, Norihiro Watanabe, Vera I. Luchkova, "Temporary Design on Public Open Space for Improving the Pedestrian's Perception Using Social Media Images in Winter Cities", 12(15), 6062, 2020

(ii) Status of collaboration (potential or possible collaborations)

- PEERS (Partners in Energy & Environment Engineering Education and Research for Sustainable development): UiT The Arctic University of Norway
- This group is collaborating with Aalto University, KTH, and VTT through NJE3.
- Discussions on wood materials are being held with Luke, a research institute in Finland.
- Continuing discussions with cold climate institutes in Europe and the US through IEA ANNEX93 activities.
- After Dr. Uto and his students visited the Building Research Institute in Fairbanks as part of the NJE3 educational program in Alaska, we received an email from them. Mori and Watanabe visited this institute in 2018. If communication continues, collaboration is possible regarding architecture and urban planning in cold regions.
- We have started communication with the Technical University of Denmark through our research in Greenland.

(iii) Contribution to society

• Leaning Satellite and Hokkaido Summer Institute under NJE3 program

(iv)Efforts needed in the future

- Research: We have applied several times for JSPS international joint research with VTT and others, but have not received funding. Without research funds, it is difficult to conduct full-scale joint research, so we need to continue our efforts to obtain research funds.
- Collaboration: Through NJE3, we have continued to collaborate with research institutions such as Aalto University, KTH, and VTT. The budgets of these programs are shrinking. The age of counterparts is increasing, and it is necessary to consider handing over to the next generation.
- Implementation of research results: This group targets actual buildings and urban planning. Therefore, social implementation of the research results has been done well.

- Johannes Hyvönen, Taro Mori, Juha Saunavaara, Pauli Hiltunen, Matti Pärssinen, Sanna Syri, Potential of solar photovoltaics and waste heat utilization in cold climate data centers. Case study: Finland and northern Japan, Renewable and Sustainable Energy Reviews 201 114619-114619 2024/9
- Osawa Hisato, Satoshi Oike, Taro Mori, Improving the Sustainability of Remote Arctic Communities with High-Energy-Efficiency Houses
- Polar Science 101101-101101 2024/7
- Supriya Khadka, Hom B. Rijal, Katsunori Amano, Teruyuki Saito, Hikaru Imagawa, Tomoko Uno, Kahori Genjo, Hiroshi Takata, Kazuyo Tsuzuki, Takashi Nakaya, Development of adaptive behaviour models for thermal comfort: Longitudinal investigation in Japanese office buildings and literature review, Journal of Building Engineering 89 109220-109220 2024/7
- Osawa Hisato, Taro Mori, Kouichi Shinagawa, Satoshi Nakayama, Hayato Hosobuchi, Emad Mushtaha
- ,(i)Digital Infrastructure and green transformation at the Arctic and North

3. Urban Design in Cold Regions

Norihiro Watanabe, Faculty of Engineering

Urban and architectural design using wind and snow simulation



- Academic-Industrial Collaboration .
- Conducting funded research and joint research

3.3) Public space design in cold regions based on analysis of human emotions using SNS



3.4) OGGs (One program for Global Goals) NJE3



This project will focus on the interdisciplinary key issues of "environmental assessment," "cultural diversity," "soil and production," "local resource development," and "disaster prevention management" in the northern region, where global issues such as climate change and historical and cultural diversity are concentrated.

3.2) Public space design based on analysis of the relationship between climate and human behavior in cold regions



- Watanabe, N., & Setoguchi, T. (2024). A Study of the Relationship between Human Behavior and Urban Design during the Winter in a High-Snowfall Urban Area. Sustainability, 16(10), 3983.
- Paukaeva, A. A., Setoguchi, T., Luchkova, V. I., Watanabe, N., & Sato, H. (2021). Impacts of the temporary urban design on the people's behavior-The case study on the winter city Khabarovsk, Russia. Cities, 117, 103303.
 - Paukaeva, A. A., Setoguchi, T., Watanabe, N., & Luchkova, V. I. (2020). Temporary design on public open space for improving the pedestrian's perception using social media images in winter cities. Sustainability, 12(15), 6062.

3.5) International exchange on research and education

UArctic Thematic Network on Arctic Urban Planning and Design

PEERS (Partners in Energy & Environment Engineering Education and Research for Sustainable development) GIVE







- , Risk Assessment of Heat Stroke during the Marathon of the Tokyo 2020 Olympics in Sapporo, Hokkaido, Sustainability 15(5) 3997-3997 2023/22
- 赤松 大成,森 太郎,林 基哉,羽山 広文,新型コロナウイルス感染症流行下の寒冷地の学校教室における室内環境と換気代替手法の評価,日本建築学会環境系論 文集/88 巻 (2023) 803 号, 2023/1/1
- Kahori Genjo, Hiroshi Takata, Kazuyo Tsuzuki, Takashi Nakaya, Study on Winter Comfort Temperature in Mixed Mode and HVAC Office Buildings in Japan, Energies 15(19) 7331-7331 2022 年 10 月 6 日
- Osawa Hisato, Taro Mori, Kouichi Shinagawa, Satoshi Nakayama, Hayato Hosobuchi, Emad Mushtaha, Analysis of Requirements for Achieving Carbon Neutrality in a Cold Dense City Using GIS, Energies 15(19) 7063-7063 2022/9/26
- Taro Mori, Taisei Akamatsu, Kouhei Kuwabara, Motoya Hayashi, Comparison of Indoor Environment and Energy Consumption before and after Spread of COVID-19 in Schools in Japanese Cold-Climate Region, Energies 15(5) 2022 年 3 月 1 日
- Koki Kikuta, Shun Omori, Masakazu Takagaki, Yasuhiko Ishii, Kazuhiro Okubo, Yuta Ohno, Yoshihiro Fujiya, Hitomi Kurosu, Tomoe Shimada, Tomimasa Sunagawa, Takuya Yamagishi, Motoya Hayashi: Verification of Ventilation and Aerosol Diffusion Characteristics on COVID-19 Transmission through the Air Occurred at an Ice Arena in Japan, Buildings, Vol.14 No.6, 1632, 2024.6.2
- Norihiro Watanabe, Tsuyoshi Setoguchi: A Study of the Relationship between Human Behavior and Urban Design during the Winter in a High-Snowfall Urban Area, Sustainability, Vol.16 No.10, 3983, May 8, 2024
- Anastasiia Andreevna Paukaeva, Tsuyoshi Setoguchi, Vera Ivanovna Luchkova, Norihiro Watanabe, Hayato Sato: Impacts of the temporary urban design on the people's behavior The case study on the winter city Khabarovsk, Russia, Cities, Vol.117, 103303, October 2021
- Anastasiia A. Paukaeva, Tsuyoshi Setoguchi, Norihiro Watanabe, Vera I. Luchkova: Temporary Design on Public Open Space for Improving the Pedestrian's Perception Using Social Media Images in Winter Cities, Sustainability, Vol.12 No.15, 6062, June 19, 2020

Investigation of the environmental impact of dump sites in small communities in Greenland

Yasum asa Tojo, Tatsuya Fukasawa, Graduate school of Engineering, Hokkaido University



Surface water quality survey



<u>.</u>	
Point	Pb[mg/L]
W1	0.04
W2	1.37
W3	0.10
W4	0.69
W5	0.10
W6	1.01
W7	0.82
W8	1.27
W9	2.27
W10	ND
W11	0.11
W12	ND

Environ. Std: 0.01 [mg-Pb/L] Effluent Std: 0.1 [mg-Pb/L]

The surface water inside the site is several hundred times higher than the environmental standard, and 10 times or more higher than the effluent standard. Glacial melt-water was flowing through the site.

<u>Survey of sediment on the</u> <u>downstream of the site</u>



Two locations exceeded environmental standards in JLT-46 test. However, high concentrations of heavy metals were not detected in the bottom mud of other points. In JLT-19 test, most of the samples were undetected. Pollution had not



Pb[µg/L]

Pb[µg/L]

Soil pollution survey



Soil Std., 10 µg-Pb/L, Hazardous waste criteria, 300 µg-Pb/L Leaching test was applied (JLT-46) L/S=10, 6 hour shaking, after filtration, GF-AAS

L/S=10, 6 hour shaking, after filtration, GF-AAS analysis.

Soil in/near the site also exceeds soil environmental standards (regarded as contaminated soil).

Furthermore, there are locations that exceed the criteria for hazardous waste. Even higher values were confirmed for Cd and Cu. It was especially high around the burning residue.

Soil quality in the dump site is equivalent to a hazardous waste disposal site.

Current activities and Future

Developments

Waste Action Plan 2020-2031

The Greenland government had announced an action plan for waste management until 2030, and plans to move hazardous materials to urban areas.



Accumulation of hazardous or recyclable waste was also done in Qaanaaq at the time of our visit (2023).



Investigation of the environmental impact of dump sites in small communities in Greenland

Yasumasa Tojo, Tatsuya Fukasawa, Graduate school of Engineering, Hokkaido University

(i) Highlights

- The environmental impact of dump site at Qaanaaq, Greenland was assessed.
- The surface water quality was surveyed at the dump site. It was several hundred times higher than the environmental standards, and 10 times or more higher than the effluent standard. The difference was due to that glacial water was running through the site.
- The soil pollution was checked, and found that the quality is equivalent to a hazardous waste disposal site.
- The sediment at the coast, downstream of the dump site, was surveyed. Two locations exceeded environmental standards in JLT-46 test. However, high concentrations of heavy metals were not detected in the bottom mud of other points. The most of samples were undetected by JLT-19 test. Pollution of the dump site was not spread to the coast.
- The Greenland government had announced an action plan for waste management until 2030, and plans to remove hazardous materials to urban areas.

(ii) Status of collaboration (potential or possible collaborations)

• Mayuko Otsuki, Makoto Tomiyasu, Jean-Baptiste Thiebot (Hokkaido University Fisheries Sciences)

(iii) Contribution to society

• Results of the survey so far were reported to residents at a workshop held in Qaanaaq village on July 28, 2024.

(iv) Efforts needed in the future

• Currently, in order to clarify the direct impact on residents, we are analyzing the heavy metal concentrations in shellfish collected along the coast downstream from the dump site. To date, we have confirmed concentrations that exceed the tolerable intake level. In the future, we will clarify whether the dump site is the cause of the high heavy metal concentrations in shellfish.

- Tojo, Y., Hayashi, N., Koots, S.: Transitions and Prospects for Solid Waste Management in Local Communities of Greenland, Material Cycles and Waste Management Research, 34(1),32-41, 2023. https://doi.org/10.3985/mcwmr.34.32
- Tojo, Y., Yasukouchi, T., : Prediction of daily leachate generation at dumpsites located in Greenland, R10-O03, ISAR-7, Tachikawa, 2023.
- Yasukoch, T., Tojo, Y., Hwang, I-H: Changes in solid waste management and impact of global warming on leachate generation in Greenland, 26th Korea-Japan Joint International Session, 2022 Spring conference of Korea Society of Waste Management, Online, May 12th, 2022.

Energy resource development and regional economy in the Russian Arctic

Shinichiro Tabata, Slavic-Eurasian Research Center, Hokkaido University

1. Influence of the war on Russia's Arctic Regions

- Before 2022: Development of the Russian Arctic regions had been centered on oil and gas and the Northern Sea Route (NSR). The West was also actively involved in this.
- A fter 2022: The Russian economy is separated from the Western world and the West is decreasing imports of oil and gas from Russia. The necessity and possibility of developing oil and gas in the Arctic is greatly reduced.

Our analysis

New NSR plan adopted in August 2022

Difficulties caused by sanctions on Russia's oil exports and embargo on LNG-related technologies

Comparison of economic performance of Yamal and Sakha

Influence of fundamental changes in Russia's oil and gas exports

2. Changes in the Russian Arctic economy: A case study of the Sakha Republic

- In addition to diamond (and gold), recent increase in oil and gas production
 - Influence of climate change and global warming and eastward shift of the Russian economy
 - Oil and gas contribute more to the Russian Federation, and diamond to the Sakha Republic in terms of economic growth and public budget revenues.
- Differences between the North (Arctic) zone and the other zones
 - Statistical analysis on municipality data (34 districts and 2 cities)
 - Strong correlation between per capita Gross Municipal Product (GMP) and the mining industry
 - Some Northern districts produce more and collect more local budget revenues than the average of all districts thank to diamonds. Public service cost is increasing due to climate change.











The share of the mining industry in GMP of Sakha in 2021.

S. Tabata, ed., Changes in the Russian Arctic Economy: A Case Study of the Sakha Republic, Hokkaido University Press, 2024, forthcoming (in Japanese).

S. Tabata, "The Contribution of Natural Resource Producing Sectors to the Economic Development of the Sakha Republic," Sustainability, Vol. 13, No. 18, 10142, September 10, 2021.

D. Mikhailova and S. Tabata, "Prospects for the development of the Northern Sea Route after February 2022: An analysis of Russia's policy in the new conditions," *Polar Science*, 101054, February 13, 2024.

Energy resource development and regional economy in the Russian Arctic

Shinichiro Tabata, Slavic-Eurasian Research Center, Hokkaido University

(i)Highlights

1. Influence of the war on Russia's Arctic Regions

- Analysis on new NSR plan adopted in August 2022
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- Comparison of economic performance of Yamal and Sakha
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 - Strong correlation between per capita Gross Municipal Product (GMP) and the mining industry

• Some Northern districts produce more and collect more local budget revenues than the average of all districts thank to diamonds.

3. Comparions of Artic areas: Russia, Norway, Alaska, and Greenland

- Fieldworks in Northern Norway (2022), Alaka (2023), and Greenland (2024)
- Comparison of benefit sharing

(ii) Status of collaboration (potential or possible collaborations)

- Joint fieldworks in Northern Norway and Greenland with Fujio Ohnishi
- Joint panel on the Influence of Russia-Ukraine crisis on the Arctic areas at the annual convention of the Japan Association for Russian and East European Studies (2023) with Fujio Ohnishi

(iii) Contribution to society

- Public seminars on decarbonization and indigenous societies (2022) and comparison of Siberia and Alaska (2024) in Tokyo
- Press release of Hokkaido University on Sakha economic Research: https://www.hokudai.ac.jp/news/2021/10/post-915.html

(iv) Efforts needed in the future

- Impact of resource development on the livelihoods and economic activities of indigenous minorities in the Russian Arctic
- Impacts of resource development on the natural environment in the Russian Arctic

- S. Tabata, 2021 "The Contribution of Natural Resource Producing Sectors to the Economic Development of the Sakha Republic," *Sustainability,* Vol. 13, No. 18, 10142, September 10.
- D. Mikhailova, S. Tabata, 2024 "Prospects for the development of the Northern Sea Route after February 2022: An analysis of Russia's policy in the new conditions," *Polar Science*, 101054, February 13.
- S. Tabata, ed., 2024 Changes in the Russian Arctic Economy: A Case Study of the Sakha Republic, Hokkaido University Press, forthcoming (in Japanese).

Digital Infrastructure and green transformation at the Arctic and North

Juha Saunavaara, Arctic Research Center, Hokkaido University

1 View PDF	Download full issue
ELSEVIER	Renewable and Sustainable Energy Reviews Volume 200, September 2024, 114619
Potenti heat ut	al of solar photovoltaics and waste ilization in cold climate data centers.
Case stu	udy: Finland and northern Japan
Johannes Hyvör Sanna Syri *	en * 凡 昭 , Taro Mori ^b , Juha Saunovaera ^c , Pauli Hiltunen ^o , <u>Matti Përssinen ^d,</u>
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	infrastructure. This study builds on the theoretical literature on infrastructure, infrastructuring and pipeline ecologies and demonstrates how the peouliar features of the Arctic, such as
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© Juha SAUNAVA E-mail: juha sauna Hokkaido Universi Collaborative Ress © Antti LAINE, M E-mail: antti Jaine	ARA, Ph.D., assistant professor varara@ucir.blwddia.ac.ja y Arciis Research, Centra and the Glubal Station for Arctic Research, Global Institution for A Ph.D. A Ph.D. Restanting Control (Control (Contr
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Abstract. The glob the development attract new data o in different parts they and the gene ity and plays an i	sa data center industry is a huge and rapidity growing sector. This growth has resulted in of significant data center clusters in viarous northern regions. Furthernors, the desire to inverter investments has been incorporated into regional development plana and strategies of the Croungolan North. Although the policy-makers even to have great expectations, ral public often know little about the industry, which consumes huge amounts of electric- memers role in the distallation process. But the work of a workform of the industry, which consumes huge amounts of electric- memers role in the distallation process. But the workford is avoid/environ.



Other events co-organized by HAI-FES:

-GX and GX at North (20-22 November 2023); Planning and implementing green transformation in northern Japan and Finland: examples and best practices from national, regional and local levels (28 April 2023); -Session at Finland Week in Hokkaido – Science Day (30 May 2022);

-Finnish-Japanese Data Center Seminar (8 February 2021).

Results made available also for wider audience in Japanese (in collaboration with 北海道ニュートビア データセンター研究会 and北海道国際交流・協力総 合センター HIECC)

- Juha Saunavaara, "インターネットと国際関係", In 北海道ニュートピアデータセンター研究会(著)・ 日経BP総合研究所イノベーションICTラボ(著)、 デジタル安全保障2040激動の時代を勝ち抜くデー タセンター戦略。日経BP, 2022, 55-67.
- Juha Saunavaara,北海道は国際データ通信のホットスポットになり得るか?北極圏光海底ケーブルシステム.In [Hoppoken(北方圈)]誌,公益社団法人北海道国際交流・協力総合センター,April 2021, Number 189.

Presentations in academic and industry-oriented events (e.g. Finnish Data Center Association. Future Data Summit 2021.)

Digital Infrastructure and green transformation at the Arctic and North

Juha Saunavaara, Hokkaido University Arctic Research Center

(i) Highlights

- Solar PV systems can cost-effectively reduce data center emissions in cold climate countries. Data center waste heat can provide value in district heating and snow melting applications. The cost-effectiveness of data center sustainability measures is largely influenced by electricity prices.
- The Nordic data center industry is tightly connected with the infrastructural, industrial and technological history of the region.
- Recent submarine communications cable projects planning to utilize the seabed of the Arctic Ocean offer potential solutions by suggesting new routes and landings and shortening the cables that carry digital communications between Europe, North America, and East Asia.
- Data centers are at the intersection of physical and digital space. New high-technology industries can inherit physical and social infrastructures affecting the course of their development. The Nordic data center industry is tightly connected with the infrastructural and technological history of the region.
- Telecommunications infrastructure impacts the environment in which it is built, and the Arctic environmental conditions, paired with long distances, small populations and limited economic opportunities, affect the infrastructuring processes. Telecommunication lines supports the exploitation of natural resources in and beyond the different parts of the circumpolar North, it also plays a role in the observation and protection of the Arctic.
- Northern and Arctic regions have played pioneering roles in data center related research and education.

(ii) Status of collaboration

- The first applications with foreign collaborators for external project funding have been made.
- Ongoing negotiations concerning collaborative research projects based on international academy-industry-government collaboration

(iii) Contribution to society

• Two popularized articles for general public have been published and one Briefing Paper is currently under preparation. Assistance has been provided to two Japanese data center business delegations, which visited Finland in the Autumn of 2023 and spring 2024.

(iv) Efforts needed in the future

• The Nordic and Hokkaido-based researchers and industries are interested in collaborating in issues related to GX and sustainable digital infrastructure. Identification of proper funding instruments and writing of successful applications are needed to actualize these plans. The mobilization of research findings into concrete actions necessitates stronger collaboration between researchers, industry and government officials/regulators.

- Hyvönen,, J., Mori, T., Saunavaara, J., Hiltunen, P., Pärssinen, M. and Syri, S. (2024). Potential of solar photovoltaics and waste heat utilization in cold climate data centers. Case study: Finland and northern Japan, Renewable and Sustainable Energy Reviews, Vol 201, 114619.
- Saunavaara, J. and Salminen, M. (2023). Geography of the Global Submarine Fiber-Optic Cable Network: The Case for Arctic Ocean Solutions, Geographical Review Geographical Review, 2023, 113:1, 1–19.
- Saunavaara, J., Laine, A., and Salo, M. (2022). The Nordic societies and the development of the data centre industry: Digital transformation meets infrastructural and industrial inheritance, Technology in Society, Vol. 69, 2022, 101931.
- Saunavaara, J., Kylli, R., and Salminen, M. (2021). Telecommunication line infrastructure and the Arctic environment: past, present and future, Polar Record, Volume 57, 2021, e8.
- Saunavaara, J. and Laine, A. (2021). Research, Development, and Education: Laying Foundations for Arctic and Northern Data Centers. Arctic and North, 42, 2021 (pp. 126– 146).

Collaboration and sharing of best practices between Sámi and Ainu: Tourism, education and international collaboration

Juha Saunavaara, Arctic Research Center, Hokkaido University

In collaboration with the ArCS II project "[北極域における適切な先住民 ツーリズム振興を通じた地域コミュニティのレジリエンス向上のメカ ニズムの解明と社会実装]" led by Takafumi Fukuyama (ended in March 2024). Supported also by the Scandinavia-Japan Sasakawa Foundation.



Events co-organized by HAI-FES:

- A small delegation from Sami Educational Institute visiting Hokkaido in June 2023 (meetings in Upopoy, Lake Akan Ainu community etc.);
- International online workshop on 7 June 2023;
- "Indigenous Peoples of the North: Comparative Approach to Sámi and Ainu culture and tourism" session at Finland Week in Hokkaido Science Day, 30 May 2022.

Collaboration and sharing of best practices between Sámi and Ainu: Tourism, education and international collaboration

Juha Saunavaara, Hokkaido University Arctic Research Center

(i)Highlights

- While adventure tourism can be part of the process in which Indigenous people claim more rights to represent their own culture, history and modernity, attention must be paid to power relations, Indigenous actors' opportunities to freely decide whether and how to become involved and the circumstances within which different Indigenous groups engage in tourism-related activities.
- The importance of discussing authenticity in the context of Indigenous tourism needs to be recognized. However, the focus should not only be on the search of authentic (or inauthentic) features or characteristics but also on power relations. Indigenous actors should have a free hand to decide whether to be involved in adventure tourism, and they should also be in charge of the process of defining what an authentic tourism experience is that they would want to be involved in.
- It is necessary to recognize that different Indigenous groups are facing very different realities and this may reflect both different interpretations of authenticity and desired forms of cooperation with non-Indigenous tourism actors.
- The COVID-19 pandemic had a huge impact on the tourism industry, including Indigenous tourism. The travel restrictions and sharp decline in tourist flows challenged many to re-evaluate the sustainability and resilience of the practices carried out during the pre-pandemic rapid growth era. The recovery strategies may guide the companies involved in Indigenous tourism to critically consider whether the growth-orientated approaches taken previously are serving the long-term future needs of the communities and whether they show respect for the environment and for past generations.

(ii) Status of collaboration (potential or possible collaborations)

- Collaboration with key Indigenous stakeholders can be continued is new forms due to threeyear Kakenhi funding (PI, Fukuyama Takafumi, Hokkaido University Center for Advanced Tourism Studies).
- Ongoing negotiations concerning the possibility to connect the existing research collaboration into Japan's next Arctic flagship project.

(iii) Contribution to society

• Besides providing new research findings, these activities have supported correspondence between Japanese stakeholders and key Sámi institutes such as the Sámi Museum and Nature Center Siida and Sami Educational Institute.

(iv) Efforts needed in the future

• The ongoing article projects need be completed successfully. Funding for long-term collaboration needs to be confirmed. It would be beneficial to extend the scope of research collaboration. Rather than focusing only on tourism, research on various sources of livelihood directly connected to the Indigenous cultures would bring new nuances to collaboration and findings made.

- Saunavaara, J., Fukuyama, T. (2024). Indigenous adventure tourism and authenticity. In G. Pomfret, A. Doran & C. Cater (Eds). Routledge Handbook of Adventure Tourism. Routledge. (Accepted to be published)
- Fukuyama, T., Kobayashi, H., Ueda, H., and Saunavaara, J. (2023) Sami indigenous tourism and snow & ice in the Arctic, Proceedings of the 37th International Symposium on the Okhotsk Sea & Polar Oceans 2023.



HAI-FES Summary Report Online version available on the ARC website Published February 2025 by Arctic Research Center, Hokkaido University Kita 21, Nishi 11, Kita, Sapporo, Hokkaido 001-0021 Japan TEL +81-11-706-9074, FAX +81-11-706-9623 E-Mail arc_inform@arc.hokudai.ac.jp Website https://www.arc.hokudai.ac.jp/en/