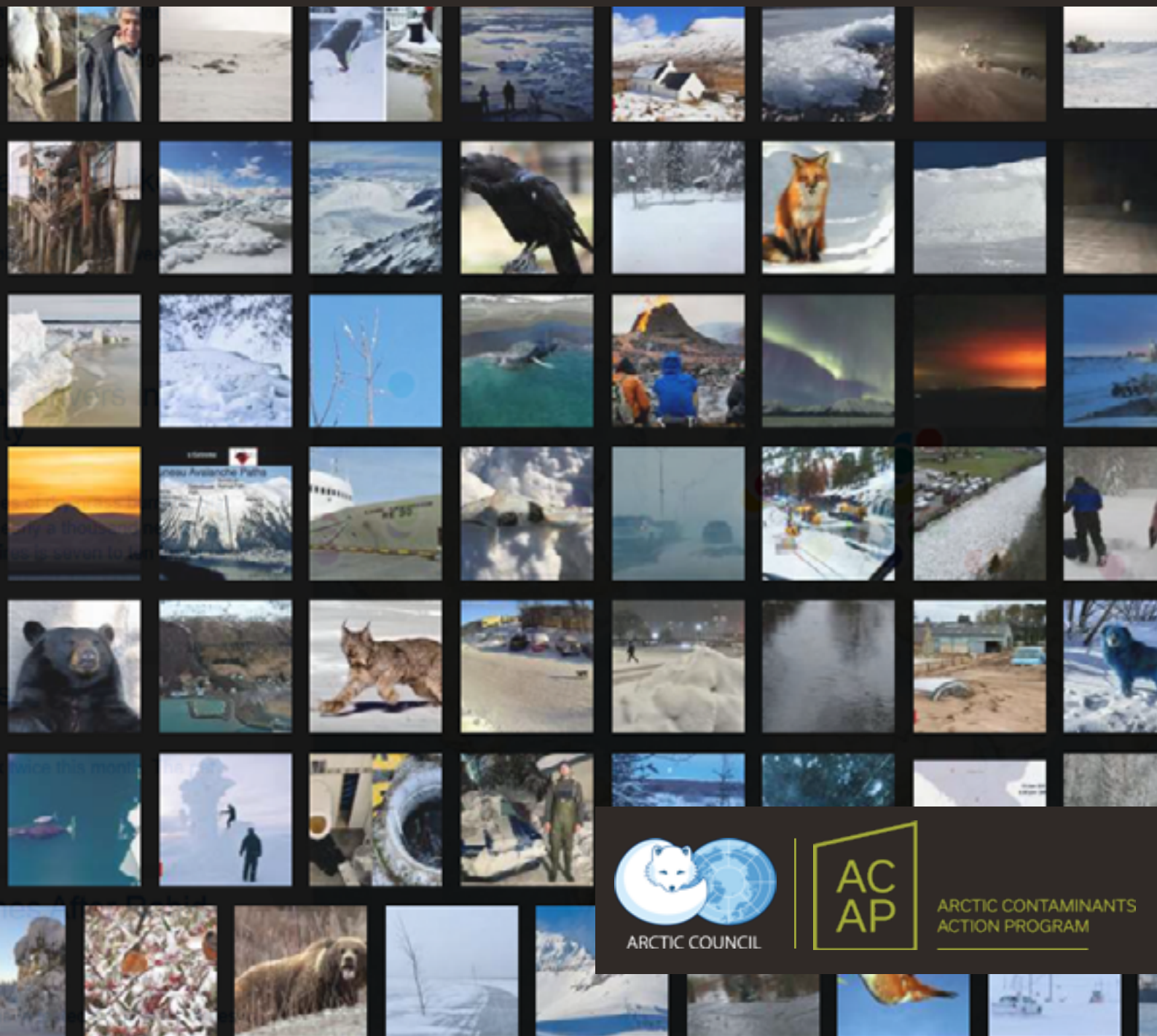


CIRCUMPOLAR LOCAL ENVIRONMENTAL OBSERVERS NETWORK (CLEO)

MAY
2021



ARCTIC COUNCIL

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Circumpolar Local Environmental Observers Network (CLEO)

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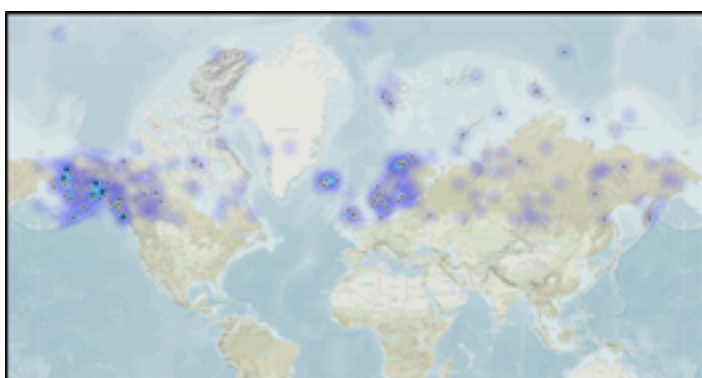
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- United States Environmental Protection Agency
- Ministry of Climate and Environment of Norway
- Swedish Environmental Protection Agency
- Ministry of the Environment of Finland

Circumpolar Local Environmental Observers Network



Local Environmental Observer (LEO) Network events posted during the Icelandic Chairmanship



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TRIBAL HEALTH
CONSORTIUM



Statsforvalteren i Troms og Finnmark



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May 2021

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*Documenting an observation. Photo
by Sylvie Blangy and Laura Martinez-
Wurtz*

EXECUTIVE SUMMARY

The Local Environmental Observer (LEO) Network started as a grassroots Alaskan movement by the Alaska Native Tribal Health Consortium (ANTHC) with funds from the US Environmental Protection Agency (US EPA) in 2009. ANTHC, in consultation with Tribal Leadership and environmental staff, developed a tool to document and share environmental observations recognizing the value of traditional knowledge and local knowledge.

LEO Network is a network of people, local observers and topic experts who share knowledge about unusual animal, environment, and weather events. The web-based platform with an original concept, where first person observers submit news articles, and make observations about unusual events and a changing environment. The entries include a description and a photo presented on a map. The focus is on specific, geo-located events which are considered symptoms at the local level and signals of potential trends regionally. The LEO Network is open for anyone and encourages inclusion of traditional knowledge and local knowledge. ***This way LEO has grown to over 3000 members.*** In practical terms, LEO members have recognized observed changes based on local knowledge and traditional knowledge and have been able to connect with other knowledge experts. As a result, remote communities have increased awareness of vulnerabilities to the impacts of climate change.

During the U.S. Chairmanship of the Arctic Council (2015-2017), the Arctic Contaminants Action Program (ACAP) and its Expert Group, the Indigenous Peoples' Contaminants Action Program (IPCAP), worked to expand the LEO Network and create the new initiative *Circumpolar Local Environmental Observer* (CLEO) Network to be used by and benefit communities across the Arctic.

Circumpolar LEO Initiative partners have been working to build on the achievements of the LEO Network in North America and to connect Arctic communities and observers. During 2016-2019, six workshops on CLEO were conducted in Finland, Sweden and Norway. The first two workshops held in Anár/Inary, Finland (June 2016) and Giron/Kiruna, Sweden (January 2017) resulted in the ***development of the Framework for the Circumpolar Expansion of the LEO Network, a ministerial deliverable to the Arctic Council in 2017***, which committed ACAP and LEO partners to continue to expand and develop the network. To follow up, the initiative partners from Finland, Norway and Sweden reached out to their Arctic academic and indigenous institutions, other observation networks, and Sámi communities across Sápmi.

During the CLEO workshops, opportunities for collaboration and sharing have become clear. Among these are: joint monitoring of climate change by reindeer herders and researchers (Laevas Reindeer Herding Community and Tarfala Research Station); joint management of protected areas by local Sámi communities and state authorities (World Heritage Laponia); environmental observations and waste monitoring in a Kiruna school

project; community-based water quality observations (Finland); Snowchange Cooperative established in late 2000 to document and work with local and indigenous communities of the Northern regions. Some impressive follow up activities have occurred as a result.

Environmental observations systems existing in the Nordic countries were presented at the workshops, potential synergies with the LEO Network were examined, and national projects for CLEO development in Sápmi were initiated. ***In general, all nationally initiated CLEO associated projects from Finland, Norway and Sweden revealed that different nature observations systems in these countries could benefit from interlinkages with the LEO Network because of the opportunities it provides to use and document indigenous knowledge.***

Cooperation with Arctic academic and indigenous institutions has provided an opportunity to increase Circumpolar LEO activity, to engage students, and explore research opportunities. ***Many of the projects within the CLEO Initiative in Finland, Sweden and Norway have been focused on youth and educational institutions of different levels*** (schools, vocational schools, colleges, universities). These activities are also in line with the [Ottawa Traditional Knowledge Principles](#), especially the Fundamental Principle 13 [12].

A Reindeer Herders Arctic Council CLEO Hub was established in Guovdageaidnu/ Kautokeino in September 2019, financed by Norway. By use of the LEO Network and participation in the CLEO Initiative, the project partners aimed to build capacity and awareness of Sámi youth of environmental and biodiversity changes in the Arctic. Community-based workshops on environmental changes and the LEO Network with indigenous herders and youth were organized at the hub. They followed up on the initial surveillance, with monitoring in the field, by starting a simple monitoring procedure for snow.

In autumn 2020, under the Icelandic Chairmanship and with support from the Swedish Environmental Protection Agency, ***the Saami Council joined CLEO Initiative in Sápmi.*** The Saami Council has been encouraged by the various CLEO Initiative efforts in the Norwegian, Swedish, Finnish and Russian regions of Sápmi.

In Alaska, ***the Alaska Native Tribal Health Consortium (ANTHC) has continued to improve on the features in the LEO Network platform,*** including translations to more languages spoken in the Arctic (Skolt Sámi, Unangam Tunuu, Yup'ik). This has enabled better circumpolar participation and helped spur the CLEO initiative. Monthly LEO Alaska Webinars continue as an important forum that brings hundreds of LEO members in Alaska together to share observations, and learn new observational skills. Additionally, the on-going quarterly One Health Group Meetings, a joint initiative between ANTHC and the US Center for Disease Control (CDC) Arctic Investigations Program, provide a regular opportunity for reviewing important One Health related events using LEO Network [20]. ANTHC developed the Northern Climate Observer (NCO) e-journal to supplement information gathered in the LEO Network, as well as an Alaska LEO almanac and calendar. Together with the Qawalangin Tribe of Unalaska, ANTHC initiated the LEO Kiosk Project. The concept was to develop physical Kiosks in different locations where local community members could gather to view LEO maps and data relevant to their culture, climate, and community issues.

Since 2019, over 900 posts from the North were shared through the LEO Network, with new observations being posted daily. The overarching themes that have emerged have included observed changes in seasonal timing, extreme temperatures, and unusual range sightings of plants and wildlife in Arctic and sub-Arctic regions.

Information sharing has been a critical component of the LEO Network. Though sharing of all information remains a challenge to fully utilizing LEO in some Arctic regions due to several factors: protection and security of culturally, economically and otherwise sensitive information; being overwhelmed with addressing rapidly accelerating climate changes on the ground and with actions toward meeting the UN Sustainable Development Goals; and the need for training and relationship building.

Across the different regions of the Arctic and sub-Arctic, the experience of using the LEO Network has been diverse. ***The LEO Network is a unique tool that all Arctic residents, scholars, indigenous leaders and***

other potential members are encouraged to join and contribute to, in order to further enrich the observational field and to strengthen bridge inter-disciplinary, diverse cultural dialogues about environmental changes. Based on the collective experiences, partners in the Circumpolar LEO initiative had identified the following ways forward in community local observations with the hopes of incorporation of indigenous knowledge and local knowledge:

- Bridging observation systems: Engagement with other observation and community-based monitoring systems would enhance common goals and objectives and create new partnerships in the Circumpolar Arctic.
- Respect for intellectual property, indigenous knowledge and sensitive information: Information derived from the LEO Network should be used with care. Users of the LEO Network should keep in mind that the information submitted to the Network is intended for sharing broadly with the membership, so contributors should avoid submitting information that they consider culturally, ethically or otherwise sensitive.
- Education and outreach: Knowledge sharing through workshops and educational events is important. The LEO Network has a good potential for diverse engagement with people having varied interests and expertise.
- Youth engagement: Investing in youth through training, dialogue and engaging in observation platforms is important to build capacity for addressing impacts related to climate change.
- System enhancements: Continued refinement and development of the LEO Network would help to ensure that Arctic residents can continue to actively contribute knowledge about climate change and related environmental impacts.



*Observing the Chukchi Sea
by Mike Brubaker*



*Photo by William Warby
(Unsplash)*

BACKGROUND

The Arctic is warming faster than any other region on Earth, and the Arctic's temperatures has risen more than twice the global average [2; 6]. Climate changes having acute impacts on our landscapes, seascapes, and plant and animal communities. Increasing temperatures accelerating sea ice loss, ocean acidification, and increasing presence of alien and invasive species are among the greatest threats. Understanding these changes at a local scale is critical for individuals and communities to respond and adapt. Adaptation to a changing climate must also be understood in the context of other global and regional socio-economic drivers of change in the Arctic countries [3; 4].

In 2009, the **Alaska Native Tribal Health Consortium (ANTHC)** established the Center for Climate and Health to help describe connections between climate change, environmental impacts, and health effects. Recognizing the value of traditional and local knowledge and the need for a tool to document and share environmental observations, the Alaska Native Tribal Health Consortium (ANTHC) developed the Local Environmental Observer (LEO) Network with funds from the US Environmental Protection Agency (US EPA). The LEO Network was launched as a tool to help the tribal health system and local observers to share information about climate and other drivers of environmental change. As a result, remote communities were able to increase awareness of vulnerabilities to the impacts of unusual changes in the environment. In practical terms, LEO members have recognized observed changes based on local knowledge and traditional knowledge, and have been able to connect with other knowledge experts.

The Obama Administration recognized the value and promise of the LEO Network, and supported its expansion and development. The LEO Network was recognized during a visit to Alaska by President Obama and members of the Administration ([GLACIER Conference](#)). In 2015, ANTHC partnered with Resource Data Inc. (RDI) to increase access and improve data management and analytical features of the network. In the same year, LEO Network was initially selected as a model program under the United States Chairmanship of the Arctic Council, to help raise awareness and improve communication about climate change in the Circumpolar Arctic.

WHAT IS THE LEO NETWORK?

[LEO Network](#) is a web-based platform where first person observations and news articles about unusual environmental events are published to raise awareness about the impacts of climate and other drivers of change. The focus is on specific events which are considered symptoms at the local level and signals of potential trends regionally. In order to encourage inclusion of both traditional knowledge and local knowledge, the LEO Network is open for anyone. LEO Network has grown to over 3000 members and is helping to increase understanding of

the emerging effects of climate change [8; 18].

CLEO or Circumpolar LEO, is an initiative adopted by the Arctic Council during the past three chairmanships, to explore the use of LEO Network as a tool that Arctic residents can use to raise awareness and understanding about environment change and to look for emerging threats and trends around the Circumpolar North.

CIRCUMPOLAR EXPANSION OF THE LEO NETWORK

During the U.S. Chairmanship of the Arctic Council from 2015-2017, the Arctic Contaminants Action Program (ACAP) and its Expert Group, the Indigenous Peoples' Contaminants Action Program (IPCAP), worked to expand the LEO Network and create the new initiative *Circumpolar Local Environmental Observer* (CLEO). It would be used by and benefit communities across the Arctic. Working with partners and communities in Canada and a partnership enabled by the Commission for Environmental Cooperation (CEC) allowed the First Nations Health Authority in British Columbia to set up their own LEO Network program. Similar LEO Network activities were

What is Sápmi?

Sápmi is the region traditionally inhabited by the Sámi people. It extends over the Northern parts of Norway, Sweden, Finland and Northwest Russia.



Map by GRID-Arendal

established by the Government of Northwest Territories. The development of regional partnerships in Canada allowed greater interaction among local and regional experts and allowed for more tailored feedback and content.

An important foundational CLEO workshop took place at the University of Victoria, BC, Canada in November 2016, which led to the development of a dedicated LEO Network program at the First Nations Health Authority.

Following the success in Alaska, LEO partners broadened outreach to Europe in 2016, taking an important next step in establishing a Circumpolar LEO Initiative or CLEO. The first CLEO workshop held outside North America took place in June 2016 in Anár/Inari, Finland, with a second workshop in January 2017 in Giron/Kiruna, Sweden. It was during these engagements that the CLEO Initiative was introduced in Sápmi area (see the textbox on the left).

The workshops brought together technical experts and community leaders from the region and resulted in the

agreement to develop a Framework for the Circumpolar Expansion of the LEO Network, a ministerial deliverable to the Arctic Council in 2017 that committed the Arctic Contaminants Action Program (ACAP) and LEO partners to continue to expand and develop the network.

Under the Finnish Chairmanship of the Arctic Council from 2017-2019, LEO Network conducted the following workshops:

- January 2017, CLEO Workshop held back-to-back with the ACAP WG meeting in Giron/Kiruna, Sweden (hereafter referred to as Kiruna Workshop);
- August 2017, CLEO Workshop held in connection with the 6th World Reindeer Herders Association Congress in Jåhkåmåkke/Jokkmokk, Sweden (hereafter referred to as Jokkmokk Workshop);
- May 2018, an outreach activity on CLEO in connection with the 49th meeting of the Barents Euro Arctic Working Group on Environment, BEAC WGE in Bihtám/Piteå, Sweden;
- June 2018, CLEO Workshop in Roavvenjárga/Rovaniemi, Finland (hereafter referred to as Rovaniemi Workshop).

During the Icelandic Chairmanship (2019-2021), the Circumpolar LEO Network has continued its development.

During a workshop hosted by Norway in connection with an ACAP WG meeting in Romsa/Tromsø in September 2019 (hereafter referred to as Tromsø Workshop), the Indigenous Centre for Reindeer Husbandry (ICR), an independent indigenous transboundary association, announced the Norwegian project on establishing the first CLEO hub in Guovdageaidnu/Kautokeino, Norway. This project represents the first dedicated CLEO Initiative partnership outside of North America. Because of the COVID-19 pandemic, activities within the CLEO Initiative have slowed down. However, the Saami Council organized a virtual workshop for Sámi youth on the Circumpolar LEO Network in January 2021.

During these years, the LEO Network has expanded considerably. In January 2019, LEO saw members in 657 communities, and that increased to 883 communities as of January 2021. Arctic countries currently comprise 345 communities in total (Fig. 2).



Figure 2. Communities in the Arctic states with registered LEO members (as of 1 January 2021).

System upgrades to the LEO Network during the Icelandic Chairmanship have enabled better circumpolar participation. These upgrades include:

- Language additions (Skolt Sámi, Unungam Tunuu, Icelandic, Russian, and Chinese)
- New Smart Phone-Friendly Web Platform
- New Post Reader-Friendly Format
- Geographic Regions Additions (Permanent Participants)
- New category super groups (Natural, Event Type, Community Impact)
- Base maps with indigenous lands
- Base maps with indigenous place names (Alaska) and Arctic language translations for content

Content posted to the LEO Network during the Icelandic Chairmanship can be found at the links below. Please note, LEO Network is working to add Permanent Participant regions as the geographic coordinates become available. For more information contact LEO Network home at ask.leonetwork@gmail.com:

- [Canada](#)
- [Greenland](#)
- [Finland](#)
- [Iceland](#)
- [Norway](#)
- [Russia](#)

- [Sweden](#)
- [USA \(Alaska\)](#)
- [Saami Council](#)
- Gwich'in Council International
- Inuit Circumpolar Council
- Russian Association of Indigenous Peoples' of the North

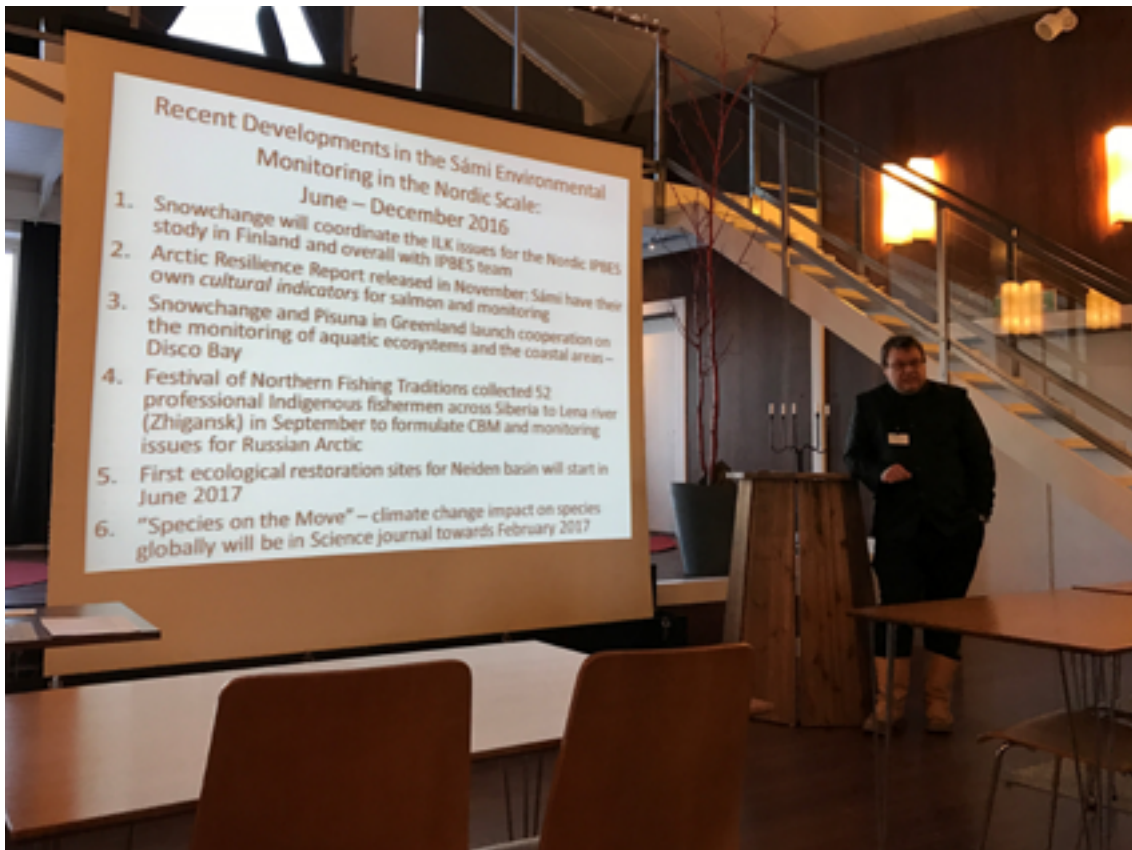
LEO Network content about some important Circumpolar trends since January of 2019 can be viewed below:

- [Extreme Temperature](#)
- [Extreme Precipitation](#)
- [Land slides and Avalanches](#)
- [Wildfires](#)
- [Algal Blooms](#)
- [Erosion](#)
- [Permafrost Change](#)
- [Wildlife Die-Off](#)

To look at circumpolar findings, LEO Network administrators at the ANTHC reviewed ranking of post frequency for the categories that were assigned. Note: there are 72 possible categories within three different 'super category' groups. These super groups cover the place in the natural environment, the type of event, and any effects on the human environment. The seasonality and timing of events by month were also explored. The geographic range of the accessed content in the system is posts from the Arctic and sub-Arctic made during 2019-2020. This resulted in a total of 936 posts.



CLEO Workshop in Anár/Inari by Vigdis Johansen



*Photos from CLEO Workshop in Giron/Kiruna
by Patrick Huber*





*Reindeer, Anár/Inari
by Francesco Ungaro
(Unsplash)*

NORDIC/SÁPMI EXPERIENCE

Starting from 2016, CLEO Initiative partners have been working to build on the success of the Alaska-based Local Environmental Observer (LEO) Network, a community-based monitoring network for rural areas, and develop the foundation for a Circumpolar Local Environmental Observer (CLEO) Network.

The CLEO initiatives in Finland, Norway and Sweden all concluded that the LEO Network has a good potential to become a handy tool to connect experts and eyewitnesses to different changes happening in the Arctic. Observers can partner with scientists, holders of traditional knowledge and local knowledge and policymakers to then create adaptation strategies that will benefit communities across the circumpolar north.

A decision to continue cooperation within this initiative and develop a framework for the expansion of the LEO Network beyond North America and establishing a CLEO Network was taken at the Inari Workshop in June 2016.

In January 2017, delegates of the Kiruna Workshop followed up on the success of the meeting in Anár/Inari and discussed different models and practices of local environmental observations existing in the Nordic countries. Such practices include: joint monitoring of climate change by reindeer herders and researchers (Laevas Reindeer Herding Community and Tarfala Research Station); joint management of protected areas by local Sámi communities and state authorities (Laponia National Park); environmental observations and waste monitoring in a Kiruna school project; community-based water quality observations (Finland); Snowchange Cooperative established in late 2000 to document and work with local and indigenous communities of the Northern regions.

Finland, Norway and Sweden, as well as Sámi representatives, expressed great interest in further development of the CLEO Initiative and discussed how they could contribute to the process. As a result, Framework for the Expansion of the Local Observer Network was developed.

ENGAGEMENT WITH ARCTIC ACADEMIC AND INDIGENOUS INSTITUTIONS, LOCAL COMMUNITIES, AND OTHER NATURE OBSERVATION SYSTEMS

Following the plan set out in the Framework, the initiative partners from Finland, Norway and Sweden reached out to their Arctic academic and indigenous institutions, other observation networks, and Sámi communities

across Sápmi.

In Finland, the initiative partners had explored possible linkages between LEO and Järviwiki system (SYKE) already in 2016, before the Kiruna Workshop. [Järviwiki](#) is a web service, which is built and maintained in cooperation by authorities and common people, and was created with the aim of sharing information on Finland's lakes to raise awareness and promote the protection of Finnish waters. Unlike SYKE Järviwiki, the LEO Network is not a platform intended for collecting structured environmental measurements. It uses member observations as opposed to instrumental measurements, and invites members to apply their knowledge (indigenous, scientific or locally based) to record events that are signals of significant environmental change. While Järviwiki does not necessarily require any traditional knowledge or expertise in local area or traditional livelihoods, and collects quantitative data, as opposed to LEO's qualitative observations. Järviwiki, however, lacks the story-telling, descriptive narrative that often is included in the LEO Network observations.

The conclusion was made: LEO Network and Järviwiki are by no means rivals. They are very different in their purpose and characteristics. A recommendation was made either to try to combine them or continue using both as parallel systems with a recognized value in each of them.

As a follow-up, the Sámi Education Institute (SAKK), in cooperation with the Ministry of the Environment, the Finnish Environment Institute (SYKE) and the Sámi Parliament developed the "AHA" (Arktiset ympäristöhavainnot or Arctic Environmental Observers) project. Within the project a special course – "Environmental Competence" – was developed. The course recognized strong connection to nature and knowledge of local conditions, especially among the students at the Sámi Education Institute working in natural industries (basic vocational qualification in reindeer husbandry). Students majoring in other fields (e.g. practical nursing, business administration, hotel and restaurant industry, etc.) also had an opportunity to take the course. During the course, students were introduced to the AHA project and demonstrations of local observations.

The project's environmental observation demonstrations focused on: 1) water samples taken and analyzed through the Järviwiki system with the help of army style water test backpacks provided by SYKE, and 2) snow observations carried out with the help of snow measurement cylinders also provided by SYKE. Both Järviwiki and LEO tool require some introduction and learning from the end-user to be able to understand the systems and to be able to smoothly use them in changing conditions. The sampling processes were filmed and a series of short videos was produced and presented at the Kiruna Workshop.

One of the most concrete results of the AHA project is a film "[Changing Environment: Stories Above the Arctic Circle](#)" [24]. This film is a collection of video interviews. Distinguished contributors interviewed in the film, including reindeer herders from the border area between Finland and Sweden and an environmental journalist, shared their views on the environment and climate in this Sámi area. The film also demonstrates measurements of snow depth with snow cylinders and sampling of water for analysis. The film has been well received and has been shown at several fora.

At the Kiruna Workshop, the Norwegian Ministry of Climate and Environment welcomed the expansion of CLEO Initiative in Norway. They provided financial support from the Ministry of Foreign Affairs to a feasibility study and a follow-up project with reindeer herders. The feasibility study was carried out in 2017 with the purpose to map interest for joining Circumpolar LEO Initiative in Norway and look for possible partners from Sápmi to cooperate with [15]. A number of relevant public administrations, interest groups, schools and research institutions were identified and contacted during the project period. Representatives from reindeer husbandry expressed great interest in CLEO, and the International Center for Reindeer Husbandry announced the idea of establishing a reindeer herders CLEO hub. Also, sea salmon fishing communities expressed their interest in addition to some others.

The Norwegian feasibility study indicated a need for support at the national level within other relevant disciplines / themes and anchoring with relevant authorities for further expansion of CLEO. It was also recommended to consider translation of LEO websites into Sámi languages and Norwegian.

Furthermore, the feasibility study found that observations of unusual environmental events from LEO Network may supplement the three Norwegian nature observation systems that were identified, especially because of the opportunities to use and document indigenous knowledge. There is a Norwegian consensus on data sharing: that institutions holding environmental data should have agreements to share this with others, within

a common framework, using common standards [22: 73]. Representatives from Species Observations System (Artsobservasjoner), Sustain (Miljølære), the Fram Center and UiT, the Arctic University in Norway expressed their interest in CLEO during the feasibility study. All published observations in the LEO Network are available for download by members. The member portal is password protected which is an important security measure to protect content. The Norwegian observation systems also require personal profiles for registration like LEO, but the data are open and searchable from public databases (except some data about endangered species).

Swedish participation in CLEO led to an identification of several diverse environmental monitoring networks that could follow on existing LEO observations, where environmental monitoring as a next step is warranted. The available monitoring networks are administered by the Swedish Environmental Protection Agency, the Sámi Parliament of Sweden and county administrations. These available resources can help researchers find solutions to issues around human health. Potential synergies with the LEO Network are being explored (see Appendix). While there are many specialized platforms that work very well for collection of environmental measurements and different media, few are focused specifically on collection of first-person observational data. This is the focus for LEO Network with the mission to highlight the importance of observation data, raise awareness about local environment change, amplify local voices, and to seek constructive and respectful ways for sharing information and collaboration between different knowledge systems.

On the occasion of the 6th World Reindeer Herders' Congress in Jåhkåmåhkke/Johkamohkki, Sweden (August 16-20, 2017), organized by the Association of World Reindeer Herders in cooperation with the International Centre for Reindeer Husbandry, CLEO Initiative partners from Alaska, Finland and Sweden presented their work at a CLEO workshop. Participants, including young reindeer herders, also met one of the developers of the LEO Network and were introduced to it. As a result, the Congress “welcome[d] local observer networks such as LEO as valuable tools for reindeer herders in sharing observations, raising awareness, and identifying answers about significant environmental challenges and possible actions” in its declaration [26].



*Not just livestock, Jåhkåmåkke/Jokkmokk
photo by Nikola Johnny Mirkovic (Unsplash)*

YOUTH ENGAGEMENT

According to surveys and interviews, 88% of young people in the Nordic region are very concerned about climate change issues [21]. So, it was only natural that most of the projects within the CLEO Initiative in Finland, Sweden and Norway have been focused on youth.

In Sweden, the LEO Network was first introduced in schools. A school project in Övre Soppero, the aim of which was to observe and document the local community involving students participation, became the first one in a series of projects that were included in the CLEO School Process 2016-2021. The school had a close collaboration with the local Soppero Sámi Association. The example of Övre Soppero school with its focus on the river, salmon and waste was used as a local, factual case study from children's perspective for the further development of the CLEO Initiative in Sweden. The project activities are based on the book "Elevernas Eller Skolans Kultur och Samhälle" (Culture and Society from Students Perspective versus School Perspective) by Pr. H. Johansson [13]. In 2018, Vittangi and Karesuando schools joined the process.

However, the most significant results came out of a Sámi-Inuit Youth Exchange project, conducted during 2018-2021 and led by the French National Scientific Research Centre and the University of Helsinki. This cross-cultural, community and school-based research project named BOAZU included cooperation with the Sámi school in Jåhkåmåkke/Jokkmokk, and a team from Inuit Baker Lake, Nunavut. CLEO became a partner of the BOAZU project, which led to the most measurable results to be used in the CLEO School Project. The advantage of this initiative was the creation of measurable subject content to form part of the curriculum to learn from and to include in school courses, in line with Ottawa Traditional Knowledge Principles, in particular, Fundamental Principle 13, which encourages to:

"Recognize the need to bridge knowledge systems, including leveraging existing indigenous knowledge networks, institutions and organizations, as well as developing education strategies to broaden mutual understanding" [12].



*Indigenous youth,
photo by Svein D. Mathiesen*

One of the main goals of the Finnish AHA-project was also raising environmental awareness among Sámi youth. The AHA project examined citizen observations and local environmental observations. Dozens of students from Finland, Sweden and Norway participated in the project. Within the framework of environmental education curricula and practical teaching work of the Sámi Education Institute, there is only a limited opportunity to involve teachers and students in regular observation work. Observation and its significance was illustrated by informing students about the background of the project (and its observation tools) and encouraging students to consider the impact of environmental change on their own lives and especially on traditional livelihoods at present and in the future. The starting point has been adaptation to changing climate. There was no possibility for regular observations or creation of statistical data series. The snow measurements were included in the project at the request of the Sámi Education Institute, because the period of ice-free water in lakes and rivers (which is required for the water test backpack usage) is quite short. There is no teaching activity in the undergraduate studies at the school during June-July, until mid-August. Demonstrations of snow measurements brought meaningful work for the mid-winter period and spring terms which make the most part of the school year for students in Anár/Inari.

The project's local observations demonstrations among Sámi Education Institute students succeeded in creating a discussion about the students' own points of view on the one hand, on the one hand, and projecting on wider climate change throughout the Arctic, including other northern indigenous peoples and their livelihoods, on the other hand. The project has also involved students in a dialogue with traditional knowledge holders, experts, and researchers.

The Finnish CLEO Initiative also utilized a joint Nordic EU-Interreg project “Biegganjunazát” (Sámi Education Institute as the lead partner), which ended on May 31, 2018. Young Sámi students from Finland, Sweden and Norway competed in the “Amazing Race” held in the fells near Hetta village on October 2-5, 2017. The race included tasks requiring traditional knowledge of reindeer and herding grounds. Some of the Järviwiki waterbag tests carried out by the students were also evaluated as part of the race tasks. In connection with late fall season and the unstable climate, attention was also paid to safety factors in the crossing of watercourses by reindeer herders as part of future adaptation to changing climate or extreme weather conditions. The students got acquainted with life jackets and dry suits while swimming in Ounasjärvi in nearly ice-cold water in October.

In Norway, a Reindeer Herders Arctic Council CLEO Hub was established in September 2019 with an aim to increase indigenous youth's knowledge about sudden environmental changes in the Arctic. The leading partners of the Reindeer Herders Arctic Council CLEO Hub are:

- The International Centre for Reindeer Husbandry (Guovdageaidnu/Kautokeino),
- Fram Centre, Romsa/Tromsø,
- University of the Arctic Institute for Circumpolar Reindeer Husbandry (UArctic EALÁT Institute) (UEI),
- Sámi High School and Reindeer Husbandry School in Guovdageaidnu/Kautokeino, Norway,
- Norwegian Institute for Water Research (NIVA).



CLEO Workshop in Romsa/Tromsø by Kristina Bär

By use of the LEO Network and participation in the CLEO Initiative, the project partners aimed to build capacity and awareness of Sámi youth of environmental and biodiversity changes in the Arctic. For this purpose, community-based workshops on environmental changes with indigenous herders and youth were organized at the hub. During the workshops, the youth learned about the CLEO Initiative. They followed up on the initial surveillance, with monitoring in the field, by starting a simple monitoring procedure for snow.

This project has also been linked to the *Nomadic Herders project* in CAFF and *EALLU* project in SDWG, coordinated by the Association of World Reindeer Herders (WRH) at the International Centre for Reindeer Husbandry.

Prior to the opening of the Reindeer Herders Arctic Council CLEO Hub, an opening seminar Traditional knowledge and the UN's sustainability goals important for Sámi reindeer herding was held on 22 August at the Sámi High School and Reindeer Husbandry School. The program included lectures and training for Arctic indigenous peoples to observe environmental changes in reindeer husbandry and to work with the LEO Network. Later the same month, CLEO Initiative was introduced to Sámi University's bachelor's course “Theoretical approach to traditional knowledge and methods for documenting and disseminating traditional knowledge”, where 28 students participated. During the fall, students together with their professors, explored such questions as: How does traditional knowledge help communities respond and adapt to climate change? How do international governance structures recognise traditional knowledge (or not)? How do interactions between humans and their environment differ from North to South?

On 9 September 2019, the Reindeer Herders CLEO Hub Opening Practical Workshop took place in Guovdageaidnu/Kautokeino with remote participation of the CLEO Initiative partners from Alaska. A special Sámi CLEO classroom was established. During the same month, the Reindeer Herders CLEO Hub was presented at the Tromsø Workshop, ACAP WG meeting, CAFF Board meeting and SDWG Plenary meeting.

Since fall 2019, Sámi youth have been collecting snow observations and other environmental observations for the LEO Network. The youth from the Sámi High School and Reindeer Husbandry School were also tasked to assess indigenous knowledge while making observations of environmental change. The youth attended a one-day training course on the use of the LEO Network, with both scientists and indigenous knowledge holders presentations. The participants learned how to monitor environmental events relevant for traditional livelihood practices, such as reindeer herding, fishing, hunting and gathering. They also realized that due to the fact that the LEO Network tool was developed for North America, some adjustments were needed to meet the needs of the Sámi in Norway, Sweden, Finland, and Russia, including some language corrections.

Indigenous peoples in the Circumpolar North are facing profound changes in their societies; climate change, biodiversity and socio-economic change are already impacting the economies and cultures of reindeer herders. Loss of grazing land and biodiversity threaten the economies, cultures, values and well-being of nomadic indigenous herding societies affecting their ability to meet UN Sustainable Development Goals. Adaptation to climate change requires training of Arctic peoples in long term sustainable planning, based on the best available knowledge – that is, both science and experience- based traditional knowledge and local knowledge. Documentation of traditional knowledge and research can and must be used to enhance local innovation and value creation. The CLEO Initiative partners seek to strengthen the resilience of indigenous societies through capacity building of indigenous youth – the Arctic leaders of tomorrow.

SNOW AND ICE OBSERVATIONS AND OTHER AREAS FOR USING THE LEO NETWORK

The report from the Kiruna Workshop clarified that small details in weather changes have a big impact on the environment. It also indicated lack of innovative tools and equipment to enable effective observation systems and information sharing, in order to understand how the reindeer herding land has been used across borders for hundreds of years. It is also important to understand how climate change has influenced reindeer herders' lifestyle today. At the community level, the tool also needs to include documentation on the historical background of the Sámi culture and lifestyle.

Both in Finland and in Norway, the observation projects under the CLEO Initiative were focused on observation of snow and ice conditions for several reasons:

1. For reindeer herders, a clear understanding of snow and ice conditions in their area has been critical to their livelihood. "Snow is a prerequisite for mobility, tracking, visibility and availability of pasture plants like lichens and grasses" [10].
2. On a larger scale, snow observations are important because changes in snow conditions can have dramatic consequences for the environment. Over the long term, snow observations can provide better understanding of climate change trends.
3. While land conflicts in Sápmi, have impact on the usage of observation networks in the region, people are more comfortable sharing snow and ice observations with community members, researchers and government agencies.

The International Centre for Reindeer Husbandry and Sámi High School and Reindeer Husbandry School have posted 100 observations in a unique CLEO exchange, related to sudden changes on ice and snow on the pastures, lakes, and rivers. These posts include observations carried out by students and teachers from Sámi High School and Reindeer Husbandry School in Guovdageaidnu/Kautokeino, who followed the winter grazing conditions in Western Finnmark in 2019-2020, when snow conditions were extremely bad for reindeer. Through small workshops and seminars, youth have been trained on issues related to rapid environmental change and extreme snow events.

At a seminar for reindeer herders, held in Guovdageaidnu on 23 June 2020, a small group of Sámi reindeer herders evaluated the snow conditions and grazing during the winter of 2019-2020. They also discussed how traditional knowledge could be used to observe and monitor changes in the environment, including a critical review of using the LEO Network to monitor snow change and make other environmental observations related to changes in the Arctic. The outcomes of this work are described in the article “Sustainable Saami Reindeer Husbandry: Leaving Nobody Behind” (Johnsen, Eira, Oskal and Mathiesen) in a manuscript in the Springer Arctic Series.

However, the Norwegian reindeer herders raised a number of issues to be considered when posting observations on the LEO website. Sámi reindeer husbandry is organized privately and their knowledge about pastures, environment and snow needs protection and, therefore, should not be published for general public on the LEO platform. A special editorial board was established to evaluate the observations posted on the LEO platform. LEO should only carefully be used in light of ongoing land claim right conflicts.

Apart from observation of snow and ice conditions, extension of observations to include other natural phenomena and biodiversity was discussed at a number of fora.

In February 2017, at the Sámi Conference in Trondheim discussions arose among Sámi youth and Esko Aikio of the Sámi Parliament on bird sightings. Such bird species as pine grosbeak, goldeneye, common scoter, wigeon, long-tailed duck, bean goose, snow bunting and ptarmigan were identified as possible important indicators species for Sámi culture (not listed in any order of importance to Sámi culture).

In 2017, a number of meetings and events took place in Finland, which helped to develop palsa definition, testing methodology and observation tool in the Sámi area. The development and piloting of a palsa observation tool, based on the Sámi traditional knowledge, is one of the concrete project results. There have been concerns about rapid disappearance of palsas, which always played an important role, especially in Sámi nomadic reindeer husbandry, e.g. as landmarks and resting places for reindeer, from which the reindeer got food more easily even in winter. The tool can be used in the smartphone interface. The palsa observation tool has been tested in the field three times in Enontekiö: at the Iitto palsa mires in May 2017, at the palsa mires in the Pöyrisjärvi wilderness area in August 2017 and a year later at Sotkavuoma (in May 2018).

In February 2018, the Alaska Forum on the Environment in Anchorage provided an opportunity for the CLEO Initiative partners from Sápmi to meet LEO system developers and other LEO Network partners. It also provided several opportunities for dialogue with Indigenous peoples of Alaska. The forum also gave many new interesting ideas for follow up such as observation and monitoring of diseases in salmon stock and discussion of the analysis of water samples from rivers and creeks, as well as furthered participants’ insight into the capabilities of the LEO Network.



*Snow observations,
photo by Katherine I. Johnsen*

PUBLIC OUTREACH AND EDUCATION

Some other events that provided an opportunity for CLEO Initiative development and expansion, inter alia, were:

- An outreach activity on CLEO in connection with the 50th meeting of the Barents Euro Arctic Working Group on Environment, BEAC WGE in Bihtám/Piteå, Sweden, May 23-24, 2018.
- BEBO meeting (Organization initiated by SAKK. BEBO means “For the Future of Reindeer Husbandry”) as part of the UArctic Congress, September 1, 2018. The audience included twenty representatives of Russian

vocational and higher education institutions.

- Conference “Arctic and Education”: EU Climate Diplomacy Week, September 6, 2018.
- Arctic Resilience Forum, Roavvenjárga/Rovaniemi, Finland, September 10-11, 2018.
- A special Nomadic Herders LEO Network Youth Session at the 2nd Arctic Biodiversity Congress, October 11, 2018.
- The 52nd meeting of the BEAC Working Group on Environment held in Stora Sjöfallet National Park on March 26-28, 2019.

On September 9-12, 2018, a course was held in Roavvenjárga/Rovaniemi, Finland for 20 Sámi youth representatives from Norway, Finland and Sweden, as well as indigenous youth from Russia. This course with a focus on the CLEO Initiative was held on the margins of the 2nd Arctic Biodiversity Congress. The course included presentations about the Arctic Council, traditional knowledge, biodiversity, and SDGs, as well as practical exercises such as mapping of land use change and learning to use the LEO Network. During the 4 days in Roavvenjárga/Rovaniemi, the indigenous youth learned about different observation tools and knowledge systems for better understanding of climate change and other environmental changes affecting the Arctic biodiversity and indigenous livelihoods. The course participants had an opportunity to attend an Arctic Biodiversity Congress lavvu dialogue “Nomadic Herders: Enhancing the resilience of pastoral ecosystems and livelihoods of nomadic herders”, organized by the International Centre for Reindeer Husbandry in cooperation with the Arctic Council’s Conservation of the Arctic Flora and Fauna (CAFF) Working Group. At this session Arctic youth and Indigenous leaders presented observations of Arctic change and reflected on solutions for the sustainable use of protected areas. Another highlight was a field trip to the [Pallas-Ylläs National Park Information Center](#), 200 km northwest of Roavvenjárga/Rovaniemi. The excursion was attended by Sámi youth, as well as by some members of the Russian indigenous delegation and the Minister of the Environment of the Sakha Republic. The LEO Network coordinators from Alaska, Finland, Sweden and Norway explained how and why observations are logged into the LEO system. The Finnish experience in management aimed at achieving the Aichi Biodiversity Targets was also discussed. The event was received with great enthusiasm and generated an animated discussion.

“The excursion to Pallas-Ylläs National Park Center can be seen as the single most important grassroots level act in demonstrating LEO Network to the stakeholders, reaching the Sámi youth and Russian indigenous delegation from Sakha Republic. It could be seen as a best practice model in reaching the target group and creating a dialogue on local environmental observation systems”
(Mika Aromäki, Finland & Ola Bergdahl, Sweden).

Swedish EPA invited Swedish and Russian Sámi representatives to take part in the meeting of the BEAC Working Group on Environment held in Stora Sjöfallet National Park on 26-28 March 2019 and to give presentations about CLEO. At the same meeting, Swedish Lapland Visitors Board (a lobbying organization owned by 16 municipalities) presented a strategy to reach a goal of increasing tourism in the Northern part of Sweden by 2030. Increased tourism has a significant impact on the Sámi life and there needs to be a discussion forum for it, and CLEO presents an opportunity to partner with such entities as the Swedish Lapland Visitors Board and the World Heritage Laponia National Park to have a wider discussion on this challenge. In connection with this meeting, other events were arranged. During a meeting at the Jokkmokk Sámi School ideas on combining the CLEO School Project with the BOAZU Sámi-Inuit Project were discussed. Representatives from each project and the Principal of the Sámi School were present. The meeting inspired a strategy and guidelines to work further with a school project in Murmansk.

The ACAP meeting held in Romsa/Tromsø, Norway, in September 2019, was attended by representatives of ACAP, IPCAP and CLEO Initiative. A representative of the Public Organization for the Promotion of Legal Education and the Preservation of the Cultural Heritage of the Sámi of the Murmansk Region (OOSMO) presented achievements of the Kola Waste Project. The Kola Waste project, as well as a black carbon project conducted in the Murmansk region, were mentioned as possible channels to introduce CLEO to the Russian part of Sápmi. This included discussions about a bus trip (now planned as a virtual trip – due to COVID-19 pandemic) from Murmansk to three different places in Sápmi, including the places suggested by the President of the Sámi Parliament of Sweden. Possible involvement of the Nenets people was also discussed. At the Tromsø workshop, a youth representative of Qawalangin Tribe of Unalaska made a presentation of the LEO Kiosk Concept and described their experience of a youth exhibition at the Nordic Museum in Stockholm, Sweden. It gave Swedish CLEO partners the idea to initiate so called "RAJD Talks" and led to the idea of development of "[The Map of Us](#)".

The "RAJD Talks" concept developed in Sweden is based on the popular "TED Talk" format. The "RAJD Talks" were presented at a local Christmas market in Övre Soppero in December 2019. During the "RAJD Talks" the local and Sámi community members shared their stories of life in Sápmi. Storytellers were expected to provide 5-12-minutes long stories on any number of topics. The Soppero Sámi Association produced a sample video on an old Sámi walking trail.

RAJD Talks developers also participated in a side event at the Arctic Frontiers in January 2020. Two delegates from Övre Soppero told the public about changes in the birdlife and, in particular, in the population of the Arctic grouse in the Saarivuoma district over the last 50 years; as well as about changes in reindeer migrations seen in retrospect. The event was filmed.

The Swedish Sámi Parliament's GIS Mapping System, which includes data layers that describe prerequisites for pastures and migration of reindeer, presents other opportunities for CLEO and RAJD Talks through its ongoing co-operation with the Galtje Museum, Östersund, Sweden, such as managing tourist trails.

Youth from Sáminuorra participated in a special Nomadic Herders Youth Session at the 2nd Arctic Biodiversity Congress, arranged by the International Reindeer Husbandry Centre in Cooperation with CAFF, in 2018, where they were introduced to the LEO Network. Youth from Sáminuorra and students from Jokkmokk Sámi Elementary School learned to use the LEO tool and had an idea of inviting Miss Greta Thunberg to a "Climate Change March". This event took place at the 415th Jokkmokk Winter Market on the Sámi National Day, 6 February 2020. Greta attended the [march](#) to support Sámi communities in their protest against climate change [\[25\]](#).



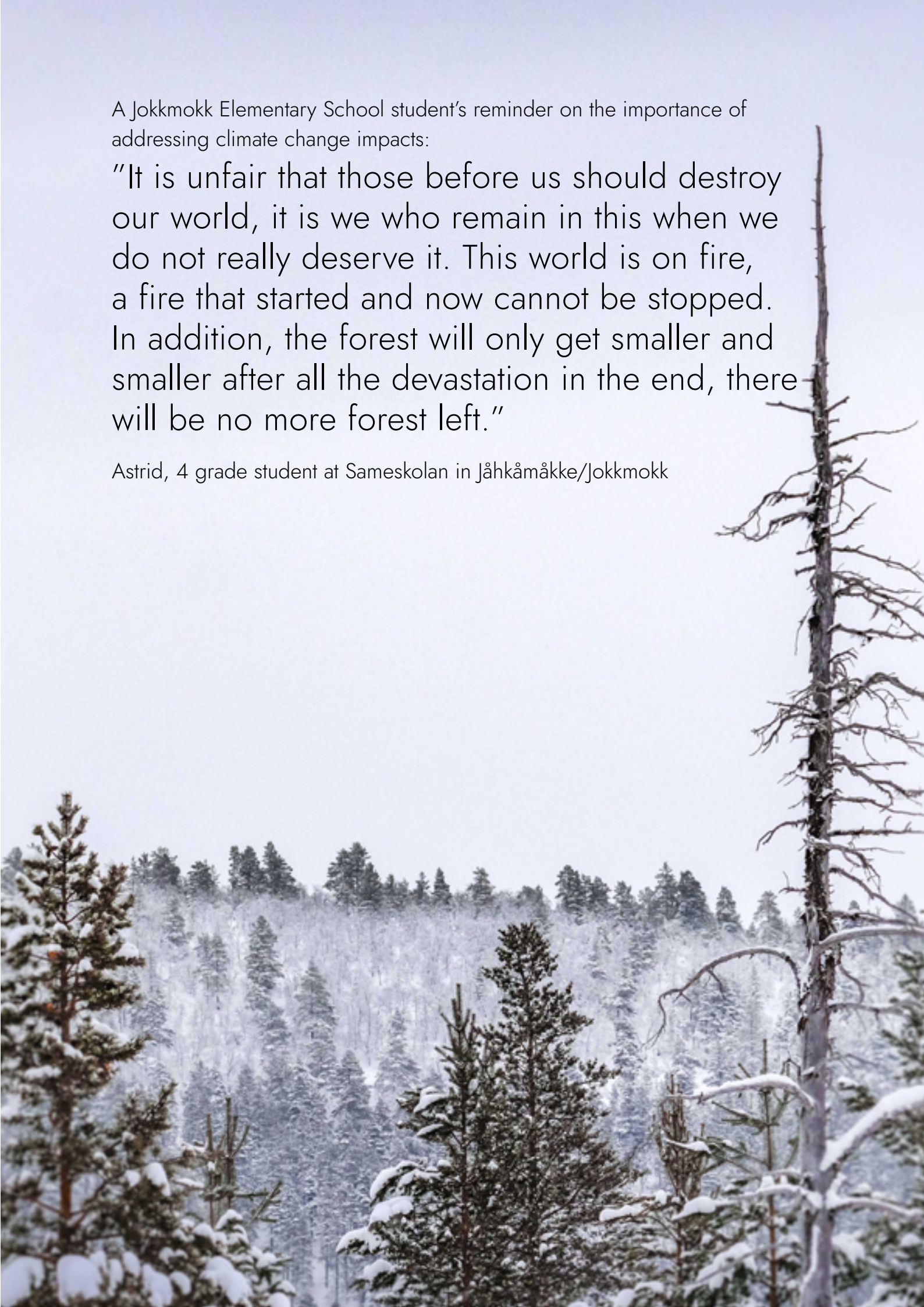
To the left: CLEO Youth workshop by Katherine I. Johnsen

To the right: photo by Francesco Ungaro (Unsplash)

A Jokkmokk Elementary School student's reminder on the importance of addressing climate change impacts:

"It is unfair that those before us should destroy our world, it is we who remain in this when we do not really deserve it. This world is on fire, a fire that started and now cannot be stopped. In addition, the forest will only get smaller and smaller after all the devastation in the end, there will be no more forest left."

Astrid, 4 grade student at Sameskolan in Jåhkåmåkke/Jokkmokk



Due to the global COVID-19 pandemic, a number of seminars, workshops and other awareness-raising and outreach CLEO events scheduled for 2020 were cancelled. Nevertheless, CLEO partners managed to have some activities within the CLEO Initiative. A small group of Sámi reindeer herders was participating in a workshop, held in Guovdageaidnu/Kautokeino, Norway on 23 June 2020. At the workshop, they evaluated the snow conditions and grazing during the winter 2019-2020, as well as how traditional knowledge could be used to observe and monitor changes in the environment. The same month, an online meeting with potential partners from Kola peninsula (Russia) was arranged to introduce the CLEO Initiative to school administrators from different communities of the Murmansk Region.

FOLLOW-UP

Different national and coordinated international outreach efforts provided inspiration for new ways of utilizing the opportunities provided by the LEO Network and for further expansion of the CLEO Initiative.

The Finnish AHA-project has generated several follow-up project ideas, which can be implemented as a cluster of individual projects with different objectives and funding sources. Some of the explored ideas for follow-up projects were focused on the Sámi architectural tradition (e.g. traditional bealjegoahti, “niliaittas”, etc.) and its importance not only in preserving Sámi know-how and cultural heritage, but also in preparing for various extreme situations in a changing world (e.g. natural livelihoods and traditional food preservation methods). In December 2018, the Sámi Education Institute held a workshop in Levi to collect project ideas and to conduct a needs assessment survey. Operation of the terrain movement observation system and the related possibilities with GIS-technology were mentioned as potential application areas. Most of the ideas discussed in Levi are waiting for a proper moment and resources to be implemented as projects.

The Sámi Education Institute will continue discussion and demonstrations of Järviwiki and LEO Network in the form of new projects. In January 2021, the Sámi Education Institute launched a new EU-Interreg Nord project “[Dialogues and Encounters in the Arctic](#)” [9], in which one of the themes of workshops will be “Local Environmental Observations”.

The Swedish Sámi Association (SSR), offers all 44 Sámi Associations in Sweden to use their live information web to reach out to each other as well as to the general public. SSR has evaluated the CLEO network as a tool and welcomes the Swedish CLEO partners to use its web platform to inform all of the other Sámi Associations about their work and initiatives.

The next step in expanding the CLEO School Project could be inclusion of a school/schools in the Murmansk region. To make the LEO Network relevant for schools, there is a need for an educational approach with clear instructions both for teachers and students. Environmental observations based on local and indigenous knowledge, should be documented, be recognized and utilized as important contributions to science. Environmental observations need to fulfil a scientific, measurable role, which will be continuously documented. Students and teachers should be involved in the development of this network together with local participants in the whole of Sápmi.

Swedish CLEO partners are in dialogue with the developers of the Swedish National Theatre’s “[Map of Us](#)” project about possible collaboration. The “Map of Us” is a cell phone app, with the help of which people take part in a performance based on reported stories and built as an imaginary walk in the future. The performance is produced by the Swedish National Theatre. The audience is guided through the performance by their own experiences of living in their neighbourhoods and regions, moreover they can interact with people surrounding them. In the course of the performance, participants with different backgrounds, representing different generations and cultures, exchange their views and reactions, which helps to form their emotional and spiritual preparedness to possible extreme weather changes and related emergencies in the future. The scenarios use knowledge about climate change trends to build awareness of possible future developments and how to respond to them. The “Map of Us” has international premiere in connection to the COP26 Climate Change Conference to be held in November 2021 in Glasgow, UK [11].

The CLEO partners see good potential in using “the Map of Us” in the Arctic. The concept needs further development to reflect the local context, wherever it is used, as well as translation to local languages. The LEO Network can contribute to this process, because LEO helps people to see themselves in a bigger context, not just as consumers but as interactive participants. Using stories collected by the “RAJD Talks” project in the “Map of Us” performances

designed for Sápmi is one of the possibilities the CLEO partners are considering.

Further CLEO Initiative activities could also include outreach to the Nenets community of the Barents Region, as well as to the Inuits of Greenland within different projects. The “Community-Based Black Carbon and Public Health Assessment” project, as well as the “Kola Waste” project under ACAP’s IPCAP Expert Group provide an opportunity for introducing the LEO Network to communities of the Murmansk region, Arkhangelsk region and the Nenets Autonomous Okrug. Another option for further dissemination of information on the LEO Network is to continue cooperation with the Inuit people of Greenland, for instance by following up on the BOAZU project.

The Reindeer Herders Arctic Council CLEO Hub (Guovdageaidnu/Kautokeino, Norway) activities will be followed up within the following projects:

- IceServices (Changes in lake and river ice cover and impacts on ecosystem services) funded by Fram Centre;
- A Feasibility study on co-production of knowledge between researchers and indigenous communities for climate change adaption funded by Nordforsk; and
- Enhancing the Resilience of Pastoral Ecosystems and Livelihoods of Nomadic Herders supported by UNEP and GEF.

Moreover, the International Centre for Reindeer Husbandry is planning to hold an Arctic Council UN WIPO workshop on reindeer herders’ intellectual property rights to initiate discussion on the need for protection of Sámi reindeer herders knowledge about pastures, environment, etc. and how it can be documented in a closed space within the LEO Network.

In autumn 2020, under the Icelandic Chairmanship and with support from the Swedish government, the Saami Council joined CLEO Initiative in Sápmi. The Saami Council has been encouraged by the strong work that has been completed by the International Centre for Reindeer Husbandry, and the various CLEO Initiative efforts in the Norwegian, Swedish, Finnish and Russian regions of Sápmi.

The Saami Council is interested in further developing the CLEO Initiative in Sápmi, as they see the use of a system where holders of indigenous knowledge share local observations. Climate change is happening rapidly in Sápmi, and stories on how it impacts the lives of Sámi people will be useful for science and society.

Land conflicts in Sápmi, have impact on the usage of observation networks in the region. Such observations combined with geographical and time data could be seen as controversial among industry. Therefore, the Saami Council would like to focus on gathering information that observers are comfortable sharing with community members and the government agencies to create an active and sharing platform.

To have a successful implementation of the project in Sápmi, it is important to first focus on finding a userbase that’s interested in sharing their knowledge on the LEO Network site. The Saami Council has a wide network of member organizations and youth organizations who have local entities all over Sápmi, and it hopes to find a way for those organizations to host local gatherings focused on the local environment with the LEO Network as a platform.

The Saami Council member organization, the Public Organization for the Promotion of Legal Education and the Preservation of the Cultural Heritage of the Sámi of the Murmansk Region (OOSMO), has participated in CLEO Initiative workshops and outreach events since 2018, using the network from the Kola Waste project. OOSMO is in dialogue with several schools on the Kola peninsula about using LEO Network. The feedback from them is that they will need a plan or active program on how to use the website effectively in education.

The Saami Council sees that one of the greatest strengths of the LEO Network is its capability to host a wide variety of information in one place. Yet the LEO Network manages to maintain a sense of a local community network on its platform. The Saami Council would like to explore ways to administer their own data from Sápmi, and give active feedback to improve the platform for Sámi users.



Alaska, photo by Taylor Murphy (Unsplash)

CONTINUED NORTH AMERICAN DEVELOPMENTS

Today, LEO is a program of the Center for Climate and Health, a collaboration between the Alaska Native Tribal Health Consortium and Alaska Pacific University. It is a network of local observers and topic experts who share knowledge about unusual animal, environment, and weather events. Observers can connect with others in communities around the world, share observations, raise awareness, and find answers about significant environmental events. Members can also engage with topic experts in many different organizations and become part of a broader observer community. The monthly LEO Alaska Webinar has historically been an important forum that brings LEO members in Alaska together to share observations and learn new observational skills. These webinars are recorded and available on the [LEO Network website](#) [16].

Another important forum for collaborating on LEO Network activities is the on-going quarterly One Health Group Meetings, a joint initiative between ANTHC and the US Center for Disease Control (CDC) Arctic Investigations Program [20]. This forum provides a regular opportunity for reviewing important one health related events using LEO Network. This forum provides a way to monitor emerging threats and transboundary trends related to one health. Hot topics include vector borne diseases, harmful algal blooms, wildlife die off events, and food security. The quarterly webinars are archived and available on the [One Health Group page](#) of the Leo Network website [17].

ANTHC developed the Northern Climate Observer (NCO) as an e-journal about climate change in the circumpolar north, to supplement information gathered in the LEO Network. The NCO provides updates on other Center for Climate and Health resources including the LEO Network and Clime Map. It also provides links to articles about climate change, and insights about healthy ways to adapt to our changing world.

In 2018, a distinguished delegation from Sweden, Finland, and Norway travelled to Anchorage, Alaska to participate in the Alaska Forum on the Environment. A LEO Network track of session featured important contributions from this panel of experts to the circumpolar expansion of the LEO Network. The CLEO Initiative partners from

Finland and Sweden presented the results of the CLEO Initiative in Sápmi. In 2019, the ANTHC Tribal Capacity and Training Program and the Qawalangin Tribe of Unalaska developed two concept papers for a LEO Kiosk Project, with funding from the US Environmental Protection Agency (US EPA). The concept was to develop a physical Kiosk, in a location where local community members in remote communities could gather to view LEO maps and data relevant to their culture, climate, and community issues. These papers provide a framework for moving this idea forward by introducing a digital content layout, as well as some considerations for customizing information in each community Kiosk. In September 2019, Representatives from the Qawalangin Tribe of Unalaska and the US Environmental Protection Agency Alaska Operations, were invited to a CAFF Board Meeting in Stockholm, Sweden to discuss the importance of ACAP/CAFF collaborations. During the meetings, they discussed youth perspectives on the conceptualization of the LEO Kiosk Project. Examining a process for customizing the project in a remote small community was part of presentation. An awareness campaign had occurred in the community of Unalaska, and these findings from Unalaska community Leaders and community partner interviews, and potential barriers and challenges were discussed at CAFF. Museum interviews were also conducted in Stockholm, Sweden and Romsa/Tromsø, Norway to discuss digital strategy. At the Nordic Museum in Stockholm, a youth and climate exhibition was discussed with the Curator as a potential CLEO Initiative activity for the future, in order to address the despair many youth were experiencing as a result of climate change. Unfortunately, the global COVID-19 pandemic prevented further development of this concept in 2020. However, the LEO Kiosk Project continues into 2021 with several meetings with agency and organizational partners occurring in an effort to bring this concept to life in the future.

Moreover, in 2020 ANTHC was able to complete its Alaska LEO almanac and calendar. These deliverables were seen as positive activities highlighting the many diverse perspectives in Alaska.

In 2021, through efforts by the Aleut International Association (AIA) with funding from US Environmental Protection Agency, the LEO Network was translated into the language of Unangam Tunuu, the language spoken by the Aleut living in the Aleutian Islands, Pribilof Islands, Commander Islands, and the Alaska Peninsula.



Above: Project team at the Nordiska Museet in Stockholm, Sweden.

To left: Carter Price. Finland Youth Exchange with Qawalangin Tribe of Unalaska.

LESSONS LEARNED

The LEO Network has grown across the Arctic and sub-Arctic-regions, in addition to other parts of the world, providing a means to plot local observations on a map and tell a unique story about environmental change in their part of the world. This local surveillance in remote communities, where often government services are limited, has served as an early warning system, informing policy and bridging communications across levels of government and among institutions. LEO assists government agencies and institutions to be in step with system changes and trends on a wider scale.

The LEO Network strives to provide a presence for Permanent Participants in the platform in recognition of geographic regions and member nations served by them. This has been accomplished by designing into the platform ways to translate content in indigenous languages, observation categories that focus on Arctic issues, and an awareness of Arctic geographic regions and indigenous place names. However, there is a desire to increase LEO Network mapping in communities for geographic areas served by all Permanent Participants. This is a task that has not yet been completed.

During the Icelandic Chairmanship (2019-2021), the LEO Network experienced steady growth in membership, an increase in observer contributions, and major improvements to the online platform that have strengthened its usability and increased access to Arctic communities. Since 2019, over 900 posts from the North were shared through the LEO Network, with new observations being posted daily. The overarching themes that have emerged have included observed changes in seasonal timing, extreme temperatures, and unusual range sightings of plants and wildlife in Arctic and sub-Arctic regions.

There are still limitations to fully utilizing LEO in some Arctic regions due to several factors:

- Protection and security of culturally, economically and otherwise sensitive information is a priority among traditional knowledge holders when considering how to participate;
- Indigenous communities are dealing with rapidly accelerating climate changes on the ground making participation in collaborative efforts such as logging observations and identifying staff to participate in regular meetings a challenge;
- Indigenous communities are fully occupied with actions toward meeting the UN Sustainable Development Goals; and
- Training and relationship building remains a critical need.

Apprehension to Sharing Information. Apprehension to sharing information is an important concern. Indigenous peoples rely on subsistence resources as a way of life, and climate change has led to a profound loss of biodiversity and increased socio-economic pressure as the availability of these resources has diminished. There is a concern that sharing information could bring on more impacts to valued and sensitive resources.

Accelerated Impacts to Time and Resources. The acceleration of climate change has impacted time and resources needed for strategic participation and networking through LEO to find solutions to climate impacts. This is because it takes time and considerable resources to assess, and articulate problems to agency partners, and in order to build partnerships that could potentially address vulnerabilities. This represents a cumulative threat to the way in which climate change impacts local communities with limited resources.

Focus on Meeting UN Sustainable Development Goals. As with many Indigenous economic and cultural activities, reindeer husbandry is dramatically affected due to loss of grazing land and biodiversity. This greatly threatens the economies, cultures, values, and well-being of the nomadic indigenous herding societies. Thus, it is a steep challenge to meet UN Sustainable Development Goals.

Many Arctic communities are overwhelmed by the cumulative impacts of climate change. Because of this, finding the time and resources to participate in observation and monitoring networks is sometimes challenging. This underlines the importance of having user-friendly tools and platforms that do not interfere with daily life, or take significant amount of time.

The Need for Training and Relationship Building. Adaptation to climate change demands training of Arctic peoples in long-term sustainable planning by trusted partners, based on the best available knowledge. To be successful, training must be conducted in a way that respects both science and experience-based traditional knowledge. Training could potentially lead to better documentation of traditional knowledge and research that enhances local innovation, value creation, and climate adaptation.

Cooperation with Arctic academic and indigenous institutions provides an opportunity to increase the LEO Network membership, to engage students, and explore research opportunities. New partnerships have been explored and established. Arctic indigenous communities, research institutions and funding agencies can use LEO as a tool for understanding trends in emerging impacts and threats, and identifying communities that can be potential research partners. This is important for institutions looking for ways to channel grant funds where they are most needed. Educational institutions of different levels (schools, vocational schools, colleges, universities) present unique opportunities for LEO Network.

Involving schools in understanding climate changes through the LEO Network has shown to possess good potential for awareness-raising and networking between communities both at regional and circumpolar levels. Youth involvement has also been one of the focuses of the Icelandic Chairmanship of the Arctic Council (2019-2021). The capacity of youth voices as an important contribution in shaping the circumpolar dialog on climate adaptation has been significant, as illustrated during numerous LEO engagements across the Arctic. The LEO Network strengthens the resilience of indigenous societies through capacity building of indigenous youth – our Arctic Leaders of tomorrow. It has created engagement opportunities for youth in providing a platform for youth observations that enable students to become aware of and participate in the dialogue about Arctic issues through different ways of learning: visual, auditory, reading/writing, and hands on (kinesthetic) learning. Youth LEO members across the Arctic have noted marine mammal strandings, snow events, and food security challenges. Youth LEO members explored new ways of sharing information through LEO, including leading discussions among peers, community members, museum groups, and businesses. The LEO Network recognizes the Arctic Youth Ambassadors who have a presence in the platform as a group.

Finally, since March 2020, community and government operations have been severely affected by the global COVID-19 pandemic on many levels. The planned activities for the Circumpolar LEO Initiative are among those hindered during the pandemic. Project partners have responded to the challenge and have worked to increase capacity to collaborate with remote communities through online meetings. Using virtual meeting formats has revealed the potential to open communication channels even further for continued CLEO cooperation. Small, remote communities have built capacity to use a variety of traditional and new media such as filming and developing social media content to share stories and to document environmental changes. However, connectivity remains a stumbling block in some regions. It is encouraging to have vast interest and a diversity of voices that continue to push the LEO Network forward, as new ideas and creative solutions can be seen on the horizon toward preservation and protection of our shared Arctic.



FINDINGS AND WAYS FORWARD

Observation networks fill a critical gap in understanding and adapting to climate change in dynamic and effective ways. ***The LEO Network is a unique tool that all Arctic residents, scholars, indigenous leaders and other potential members are encouraged to join and contribute to, in order to further enrich the observational field and to bridge inter-disciplinary, diverse cultural dialogues about environmental changes.*** The LEO Network has been extremely valuable in better understanding the environmental issues important to the many diverse voices among indigenous cultures in the Circumpolar Arctic, such as impacts to subsistence resources and food security. It is a tried-and-true observation system, which fills a significant niche that gives voice to individuals based on the sense of place. Thus, it is worth further attention and support. LEO Network is a platform for sharing, documenting and discussing environmental events, concerns and solutions that lead to better cooperation in the Arctic. It bridges knowledge between cultures, various levels of government, academic institutions and organizations. It is in line with recommendations of several AMAP and CAFF reports [1; 19].

Across the different regions of the Arctic and sub-Arctic, the experience of using the LEO Network has been diverse. Based on the collective experiences, partners in the Circumpolar LEO initiative had identified the following ways forward in community local observations with the hopes of incorporation of indigenous knowledge and local knowledge:

- ***Bridging Observation Systems.*** *Engagement with other observation and community-based monitoring systems would enhance common goals and objectives, and create new partnerships in the Circumpolar Arctic.* Being a community-based network, the LEO Network is complimentary to other citizen and local community-based observation systems [14]. The LEO Network tells a story which can serve as a piece to the complex puzzle we face today about the impacts to the environment. It is recognized that the combination of many different approaches will be necessary to address the complex effects of climate change on future generations [5: 253]. The LEO Network can serve as a tool for learning, awareness-raising and planning for climate change adaption. For example, the change in reindeer migratory routes due to late freezing of rivers is of interest across cultural and geographic boundaries, and knowledge of this change could assist environmental planners and policy-makers.
- ***Respect for Intellectual Property, Indigenous Knowledge and Sensitive Information.*** Information

derived from the LEO Network should be used with care. Users of the LEO Network should keep in mind that the information submitted to the Network is intended for sharing broadly with the membership, so contributors should avoid submitting information that they consider culturally, ethically or otherwise sensitive. The LEO Network has a track record of being a place where observers can feel safe and respected sharing their observations. Its value is best expressed as a tool that recognizes different knowledge systems in examining emerging signals of change, and respects cultural sensitivity. CLEO Hubs, managed by trusted individuals, can help facilitate this process.

- **Education and Outreach.** *Knowledge through workshops and educational events is important. The LEO Network, has a good potential for diverse engagement with people having varied interests and expertise.*
- **Youth Engagement.** Youth hold the key to finding solutions that positively impact policy and action toward a sustainable environment. *Investing in youth through training, dialogue and engaging in observation platforms is important to build capacity for addressing impacts related to climate change.* A focus on giving voice to youth through the LEO Network could continue in the following ways: outreach and education, creative involvement in LEO Kiosk development, LEO youth museum exhibitions, and incorporating youth perspectives in improving the LEO Network. Youth LEO Network projects will bridge the gap in communications among generations.
- **System Enhancements.** *Continued refinement and development of the LEO Network would help to ensure that Arctic residents can continue to actively contribute knowledge about climate change and related environmental impacts.* The LEO Network will continue to develop the platform to improve the user experience by adding more languages spoken in the Arctic, recognition for Arctic geographic regions and topics, and the use of the platform as a human resource for connecting with members across the North.

Photo by Mats Speicher (Unsplash)



GLOSSARY OF TERMS

Alaska Native Tribal Health Consortium (ANTHC) – The Alaska Native Tribal Health Consortium is a non-profit Tribal health organization designed to meet the unique health needs of Alaska Native and American Indian people living in Alaska. In partnership with the more than 180,000 Alaska Native and American Indian people that we serve and the Tribal health organizations of the Alaska Tribal Health System, ANTHC provides world-class health services, which include comprehensive medical services at the Alaska Native Medical Center, wellness programs, disease research and prevention, rural provider training and rural water and sanitation systems construction. The Consortium co-manages the Alaska Native Medical Center with Southcentral Foundation.

Alaska Pacific University (APU) - is a private university in Anchorage Alaska. It was established as the Alaska Methodist University in 1957, by Peter Gordon Gould, an Unagan minister from Unga, Alaska. The university and renamed to APU in 1978. The main campus is located adjacent to the University of Alaska (UAA) and the Alaska Native Medical Center. APU is the home of the International Center for Climate and Health, which along with ANTHC, hosts the LEO Network.

Arctic Contaminants Action Program (ACAP) – ACAP is one of the six Working Groups of the Arctic Council, which works to prevent and reduce pollution and environmental risks in the Arctic. ACAP carries out demonstration projects to raise awareness and show possibilities to cut pollution in the Arctic and clean up. ACAP encourages nations to strengthen policies and take actions to reduce pollutants and mitigate associated environmental, human health and socio-economic risks.

Center for Climate and Health (CCH) – The Center is a partnership between Alaska Pacific University (APU) and the Alaska Native Tribal Health Consortium (ANTHC). It was established in 2009 as a result of the signing of a resolution from the ANTHC Board of Directors, in 2008. The resolution was in response to growing concerns about the impact of climate change on rural infrastructure, food and water security and incidence of illness and injury. The mission is to increase understanding and raise awareness about the connections between climate change and community health. A further goal is to identify adaptive strategies that support health and wellness. The Local Environmental Observer (LEO) Network, is a program of the CCH. Other products include: Climate Change Health Bulletins which provide descriptions of climate to health relationships; the One Health Group, a quarterly interagency forum focused on surveillance emerging threats; and The Northern Climate Observer, a weekly e-new publication which features first person observations and local news articles.

Circumpolar Local Environmental Observer (CLEO) Initiative – CLEO or Circumpolar LEO, is an initiative adopted by the Arctic Council during the past three Chairmanships, to explore the use of LEO Network as a tool that Arctic residents can use to raise awareness and understanding about environment change and to look for emerging threats and trends around the Circumpolar North.

Commission for Environmental Cooperation (CEC) – CEC is international collaboration between Canada, Mexico and the United States on environmental issues of common interest, established to conduct research, provide tools and training, and provide a unique space for decision-makers and the public to engage on environmental policy issues affecting the North American region.

Indigenous Peoples Contaminants Action Program (IPCAP) – IPCAP is one of ACAP's Expert Groups, which was established to enhance involvement of Arctic indigenous peoples' communities in reducing exposure and impact of contaminants in their communities by developing, coordinating and facilitating Arctic Council demonstration projects based on local participation and ownership. Being one of ACAP's subsidiary bodies, the IPCAP EG acts as a strengthening and supporting mechanism, proposing actions to reduce emissions and other releases of pollutants, as well as to reduce the environmental, human health and socio-economic risks faced by Arctic indigenous communities. Through pilot projects and work of the IPCAP EG, the ACAP WG demonstrates opportunities for identification of local sources of contamination, and remediation of contaminated sites in Arctic indigenous communities. ACAP WG relies on its Member States to contribute to scaling up efforts through strengthening their national policies.

International Centre for Reindeer Husbandry, ICR (Guovdageaidnu/Kautokeino, Norway) – The International Centre for Reindeer Husbandry (ICR) was established by the Norwegian Government in 2005 in Guovdageaidnu/Kautokeino, as a contribution to the unique international cooperation of circumpolar reindeer herding peoples. ICR is an independent professional unit, with its own board and budget. Its core funding is provided by the Norwegian Government through annual grants from the budget of the Ministry of Reform and Government Administration. ICR's purpose is to contribute to maintaining and development of sustainable reindeer husbandry in the north, strengthen the cooperation between the reindeer herding peoples, document the traditional knowledge of reindeer herders, and to communicate knowledge about circumpolar reindeer husbandry to different target groups. ICR also hosts the secretariat for the Association of World Reindeer Herders (WRH). The high level of expertise developed by staff and international board of ICR has enabled the undertaking of work that is unprecedented in Norway in terms of the depth and richness of its engagement with local and indigenous communities in the Arctic and sub-Arctic. Alongside proven work at the grassroots level, ICR has a strong and unique international network of collaborators and cooperative parties, including cooperative agreements with scientific, educational institutions. The center also helps to protect reindeer husbandry traditional knowledge and promote knowledge and understanding of reindeer husbandry. The center, among other things, has close cooperation with reindeer husbandry workers in Russia.

Local Environmental Observer Network (LEO) - [LEO Network](#) is a network of people, local observers and topic experts who share knowledge about unusual animal, environment, and weather events. This web-based platform with an original concept, where first person observers submit news articles, and make first person observations about unusual events and other symptoms of environmental change. The entries include a description and a photo presented on a map, as well as time stamps, geocoding and value added content such as satellite images. The focus is on specific, events which are considered symptoms at the local level and signals of potential trends regionally. The LEO Network is open for anyone and encourages inclusion of traditional knowledge and local knowledge.

Norwegian Institute for Water Research (NIVA) is Norway's leading institute for fundamental and applied research on marine and freshwaters. NIVA was founded in 1958 and is now a non-profit research foundation with a board appointed by the Ministry of Climate and Environment, the Research Council of Norway and employees. NIVA combines research, monitoring, evaluation, problem-solving and advisory services at international, national and local levels and plays a vital role as a provider of research-based studies and advisory services on environmental issues. NIVA's broad scope of scientific competence, research expertise and long-term environmental data series are important to Norwegian business and industry, public administration on municipal, regional and national levels. NIVA has extensive experience in international research cooperation with international assignments accounting for about 20% of our turnover. NIVA has over the years contributed to projects in over 70 countries, carrying out research and monitoring, as well as innovation and development work. NIVA employees have professional backgrounds in a broad spectrum of disciplines, encompassing both natural

and social sciences, including biology, limnology, geology, hydrology, environmental technology, geography, resource management, governance and environmental economics.

Observation - In LEO Network the term observation means what is seen, versus the term monitoring which means what is measured. Often the observation is the first step in educating others on an environmental issue. Monitoring takes it a step further by generating data (on environmental conditions) that can be quantitatively evaluated. For example, a LEO Network member might report a snow event for initial surveillance. A parallel effort might involve taking snow measurements as a way to generate baseline monitoring data.

One Health – an approach to public health that also considers the health of the environment, plants and wildlife.

Sámi Education Institute (SAKK) – The Sámi Education Institute (SAKK) is a vocational college with a central role in developing the needs of its people and the Arctic region. It is the only Indigenous people's institute of post-secondary trade school education in Finland, located above the Arctic Circle, with three campuses in the homeland of the Sámi. The institution organizes multidisciplinary contact-based and distance virtual education classes, workshops, and degree programs for young adults and mature students. The core curriculum supports the livelihoods of the Sámi with emphasis on the development of the Sámi languages and Sámi cultures, to promote nature-based occupations and employment. SAKK encourages partnerships with national and international networks in preserving and developing the education of indigenous cultures and livelihoods in the circumpolar north. All educational programs, courses, and workshops are taught in Finnish and/or Sámi. Occasionally, other languages of instruction may be used.

Sámi High School and Reindeer Husbandry School in Guovdageaidnu/Kautokeino, Norway – The school's ultimate goal is to prepare Sámi youth for the challenges of functioning and thriving in local, national and international contexts. The school wants to contribute to developing and strengthening identity, language and culture among the Sámi youth. The school was established in 1953, particularly for the Sámi people in Norway. Back then it had courses in sewing and weaving, working with hard materials as wood, iron and metal, and also provided courses in reindeer husbandry. Guovdageaidnu is a vibrant Sámi-speaking environment, so is it at the school. The school's curriculum is tailored to and rooted in the local needs and values of the Sámi language and culture, but within the Norwegian system. All pupils study the Sámi language at different levels. The school is a state-run school that is open to pupils from the whole country, as well as from the Sámi regions of Northern Sweden, Finland and Russia. The school's vision is that, on leaving school, pupils shall have a solid body of knowledge rooted in the Sámi culture. The school is officially recognized as a distinctly indigenous school of the upper secondary level. This gives students unique opportunities for communication and exchange with other indigenous schools. The students can take either subject-specific academic courses or vocational programs. The school staff also teach net-based courses in Sámi for students in other schools. Students from the whole country can do reindeer husbandry and Sámi handicraft programs at the school. Traditional knowledge is important for the school.

Sápmi (and corresponding terms in other Sámi languages) – refers to the region traditionally inhabited by the Sámi people. It extends over Northern parts of Norway, Sweden, Finland and Northwest Russia.

Traditional Knowledge – Traditional Knowledge is a systematic way of thinking and knowing that is elaborated and applied to phenomena across biological, physical, cultural and linguistic systems. Traditional Knowledge is owned by the holders of that knowledge, often collectively, and is uniquely expressed and transmitted through indigenous languages. It is a body of knowledge generated through cultural practices, lived experiences including extensive and multigenerational observations, lessons and skills. It has been developed and verified over millennia and is still developing in a living process, including knowledge acquired today and in the future, and it is passed on from generation to generation ([Ottawa TK Principles](#)).

Indigenous Peoples' Knowledge has always held significant value in the Arctic Council. The Ottawa Declaration (1996) recognized “the traditional knowledge of the indigenous people of the Arctic and their communities” and took note “of its importance and that of Arctic science and research to the collective understanding of the circumpolar Arctic” [7; 23].

While the term “traditional knowledge and local knowledge” is used in key Arctic Council documents, e.g. in Ministerial declarations, the use of other terminology – such as “indigenous knowledge” – by the Permanent Participants, Working Groups or by anyone else is not restricted.

University of the Arctic Institute for Circumpolar Reindeer Husbandry (UArctic EALÁT Institute) (UEI) - On the Occasion of the 4th World Reindeer Herders' Congress in Guovdageaidnu/Kautokeino, Norway (30 March – 3 April 2009), the Kautokeino declaration decided to support the establishment of University of the Arctic Institute for Circumpolar Reindeer Husbandry. University of the Arctic Board of Governors approved the establishment of the UArctic Institute of Circumpolar Reindeer Husbandry on November 2, 2009. The institute is a virtual institute, established to increase the cooperation between the partners (12) related to information exchange, research and education in the circumpolar reindeer husbandry.

Since 2009 more than 260 indigenous students have participated in courses and training related to Arctic leadership, traditional knowledge, biodiversity and food systems. The institute develops also online courses on adaption to globalization of the Arctic. The institute has been supported by Prince Albert II of Monaco since it was established. The activities of the institute are to: 1) increase public understanding of Arctic issues and challenges for indigenous peoples and reindeer husbandry, including monitoring; 2) increase the educational and research capacity of Arctic peoples, especially indigenous and reindeer herding peoples; and 3) replicate to other regions affected by climate change and globalization the indigenous peoples' gained knowledge and ability to deal with such changes. The Institute has a circumpolar focus, and works for the benefit of Arctic residents, especially focusing on indigenous and reindeer herding peoples. The target groups are: Indigenous circumpolar reindeer herding peoples and youth, academic institutions, education and research institutions in the north.

The World Reindeer Herders' Congress is a unique cultural and professional event that brings together representatives of reindeer herding peoples from around the circumpolar region. The Congress is organized by the Association of World Reindeer Herders (WRH) in cooperation with the International Centre for Reindeer Husbandry. International cooperation in reindeer husbandry in modern times dates back to 1993 with the Reindeer Peoples' Festival in Romsa/Tromsø, Norway. Previous congresses have been held in Nadym (Russia), Anár/Inari (Finland), Yakutsk (Russia), Guovdageaidnu/Kautokeino (Norway), Aoluguya (China) and most recently (2017) in Jåhkåmåkke/Jokkmokk (Sweden).

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APPENDIX

SWEDISH ENVIRONMENTAL MONITORING NETWORKS OF RELEVANCE FOR CLEO

SUBJECT	WHAT KIND OF DATA?	RESPONSIBLE CLIENT	DATA HOST	OBSERVERS
Environmental toxins	Metals and organic pollutants in sediment	Swedish Environmental Protection Agency	The Geological Survey of Sweden, SGU	The Geological Survey of Sweden, SGU
	(link in Swedish: Metaller och organiska miljögifter i sediment)		SGU is the expert agency for issues relating to bedrock, soil and groundwater in Sweden	
Environmental toxins	Metals and organic material in biota	Swedish Environmental Protection Agency	The assignment will be transferred to SGU in 2017	The Geological Survey of Sweden, SGU
	(link in Swedish: Metaller och organiskt material i biota)			
Environmental toxins	Screening of environmental pollution	Swedish Environmental Protection Agency	IVL Swedish Environmental Research Institute	IVL Swedish Environmental Research Institute, Different Universities and Consults.
	(link in Swedish: Screening av miljögifter)		IVL has a broad environmental profile, they combine applied research and development with close collaboration between industry and the public sphere.	

Health	Health-related environmental monitoring		Institute of Environmental Medicine, IMM	
	(link in swedish: Hälsorelaterad miljöövervakning)		At IMM a wide range of research topics are covered in the areas of epidemiology, toxicology, physiology, environmental medicine and risk assessment.	
	Health-related environmental monitoring involves long-term monitoring of environmental factors in the environment that can affect human health.	Swedish Environmental Protection Agency		Different Universities
Air	Data for atmospheric chemistry. Dispersion calculations and risk assessments, e.g atmospheric chemical calculations on the formation and deposition of ozone, particles, PAH or other substances with or without chemical reaction schemes.		Swedish Meteorological and Hydrological Institute, SMHI	
	(link in Swedish: Atmosfärskemiska data Ozon och spridningsberäkningar)	Swedish Environmental Protection Agency	SMHI is an expert agency under the Ministry of the Environment and Energy. Through expertise in meteorology, hydrology, oceanography and climatology, SMHI contributes towards greater public welfare, increased safety and a sustainable society.	Swedish Meteorological and Hydrological Institute, SMHI

Air	Air quality data			
	<p>Measurement data for air and rain levels and for metals in mosses. Annual statistics for the most common air pollutants are available in the portal for hourly and daytime.</p> <p>(link in Swedish: Luftdata)</p>	Swedish Environmental Protection Agency	Swedish Meteorological and Hydrological Institute, SMHI	Swedish Meteorological and Hydrological Institute, SMHI
Agricultural land	<p>Nutrients, pesticide, trace elements and soil compaction</p> <p>Data host - Agricultural land</p> <p>(link in Swedish: Närsalter, bekämpningsmedel och spårämnen. Markpackning).</p>	Swedish Environmental Protection Agency	Swedish University of Agricultural Sciences, Department of Soil and Environment	Swedish University of Agricultural Sciences
			Environmental data base (Miljödata-portalen)	
Wetland	Wetlands monitoring			
	<p>(link in Swedish: Våtmarksinventeringen)</p>	Swedish Environmental Protection Agency	<p>Reports and geographic data with information about nature and environment, such as environmental monitoring, area protection and inventory results and geographical analyzes. You can search for information across Sweden or choose a specific area.</p>	

[Biodiversity and species](#)

(link in Swedish: [Artdata \(ej marina/limniska arter\)](#))

Biodiversity	The Swedish Species Information Centre accumulates, analyses and disseminates information concerning the species and habitats occurring in Sweden.	Swedish Environmental Protection Agency	Swedish University of agricultural science, The Swedish Species Information Centre
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Biodiversity	Large Carnivores Observations of tracks, signs or sightings of large carnivores in Scandinavia	Swedish Environmental Protection Agency	Norwegian Institute for Nature Research (NINA)	Everyone can register observations of tracks, signs or sightings of large carnivores in Scandinavia.
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[Small Game Hunting Statistic](#)

Biodiversity	Capercaillie, Black Grouse, Willow Grouse, Rock Ptarmigan, Hazel Grouse, Hare.	County Administrative Boards of Sweden	County Administrative Boards of Sweden	Hunters
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[Groundwater chemistry](#)

(Link in Swedish: [Grundvatten-kemidata](#))

Freshwater	The Groundwater Chemistry Archive, containing chemical analyses of well water. The Groundwater Monitoring Network, which comprises time-series data showing variations in groundwater levels and chemistry over time.	Swedish Agency for Marine and Water Management	The Geological Survey of Sweden, SGU	The Geological Survey of Sweden, SGU and county administrative boards
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[Chemical and biological monitoring in inland waters.](#)

Freshwater	<p>(Link in Swedish: <u>Kemiska och biologiska data i sjöar och vattendrag (ej fisk).</u>)</p> <p>National data host for data collected from national and regional freshwater monitoring, as well as from recipient monitoring.</p>	Swedish Agency for Marine and Water Management	Swedish University of agricultural science, Department of Aquatic Science and Assessment	Swedish University of agricultural science and county administrative boards
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[Data on Fish and Fishing](#)

Freshwater, Coast and Sea	<p>(Link in Swedish: <u>Fiskdata i sjöar, vattendrag och kust.</u>)</p> <p>Data host for fish data collected in both national and regional environmental monitoring.</p>	Swedish Agency for Marine and Water Management	Swedish University of agricultural science, Department of Aquatic Resources.	Swedish University of agricultural science and county administrative boards
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[Oceanographic observations](#)

(Link in Swedish: [Hydrografiska, kemiska och marinbiologiska data från Östersjön och Västerhavet](#)).

Coast and Sea	<p>Oceanographic observation data comes from SMHI's measurement stations along the coast and at sea. A station can deliver data for several oceanographic parameters. The following parameters are currently available: Significant wave height, Current velocity and direction, Salinity, Sea temperature, Sea level.</p>	Swedish Agency for Marine and Water Management	Swedish Meteorological and Hydrological Institute	Swedish Meteorological and Hydrological Institute
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[Bathing Water Quality](#)

(Link in Swedish: [Badvattenkvalitet \(havochvatten.se\)](#))

Bathing Water	<p>Interactive map (in Swedish) that shows the water quality for the swimming areas monitored in Sweden. For example, results of the most recent samplings are shown, as well as observations of algal blooms, and if there is a current warning against bathing in that area, contact information and whether or not the site is an EU bathing site.</p>	Swedish Agency for Marine and Water Management	<p>Municipalities</p> <p>The Public Health Agency of Sweden</p>	Municipalities
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Reindeer Husbandry	Populations statistics of semi-domestic reindeer in Sweden	Sámi Parliament of Sweden	Sámi Parliament of Sweden	Reindeer Herders, Slaughter-houses, County Administrative Boards of Sweden
Reindeer Husbandry	Reindeer Husbandry Plans (RHP)			
	Digital capture of traditional knowledge. Land-use Plans for reindeer husbandry in Swedish Reindeer Husbandry Plans (RHP).	Sámi Parliament of Sweden	Sámi Parliament of Sweden	Reindeer Herders
	(Link in Swedish: Renbruksplan) Article in English			

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