

Swedish Infrastructure for Ecosystem Science (SITES)



Annual Report 2021



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1 Introduction

SITES (Swedish Infrastructure for Ecosystem Science) is a national infrastructure for terrestrial and limnological field research. SITES aims to promote high-quality research through long-term field measurements and experiments and by offering expertise that attracts both Swedish and international researchers to use the infrastructure. An additional and important goal is to make data openly available. The core of SITES consists of nine distributed research stations that represent all Swedish climate zones as well as a variety of different ecoregions (Figure 1). SITES research stations are: Abisko, Asa, Erken, Grimsö, Lönnstorp, Röbbäcksdalen, Skogaryd, Svartberget and Tarfala. Bolmen is an additional research station associated with SITES since 2018. The distributed nature of the infrastructure across Sweden and its diverse habitats and ecosystems offers research opportunities in many systems, including agricultural landscapes, forests, alpine landscapes, wetlands, lakes, and watercourses.

Furthermore, SITES helps to better understand the grand challenges our modern societies face on a global scale, such as climate change, biodiversity loss, and man-made degradation of ecosystems. The infrastructure embraces the connectivity between landscape types and their individual elements, creating a research environment that allows scientists to view their study system in a broader context. To encourage these activities SITES has established three Thematic Programs, SITES Water, SITES Spectral, and SITES AquaNet, that bind the stations together and enable the comparison of data and experiments from different climate zones and landscape elements. The Thematic Programs are led by experts in the respective research fields and coordinated by central support for data handling, streamlining the infrastructure activities, and connecting the SITES community with researchers.

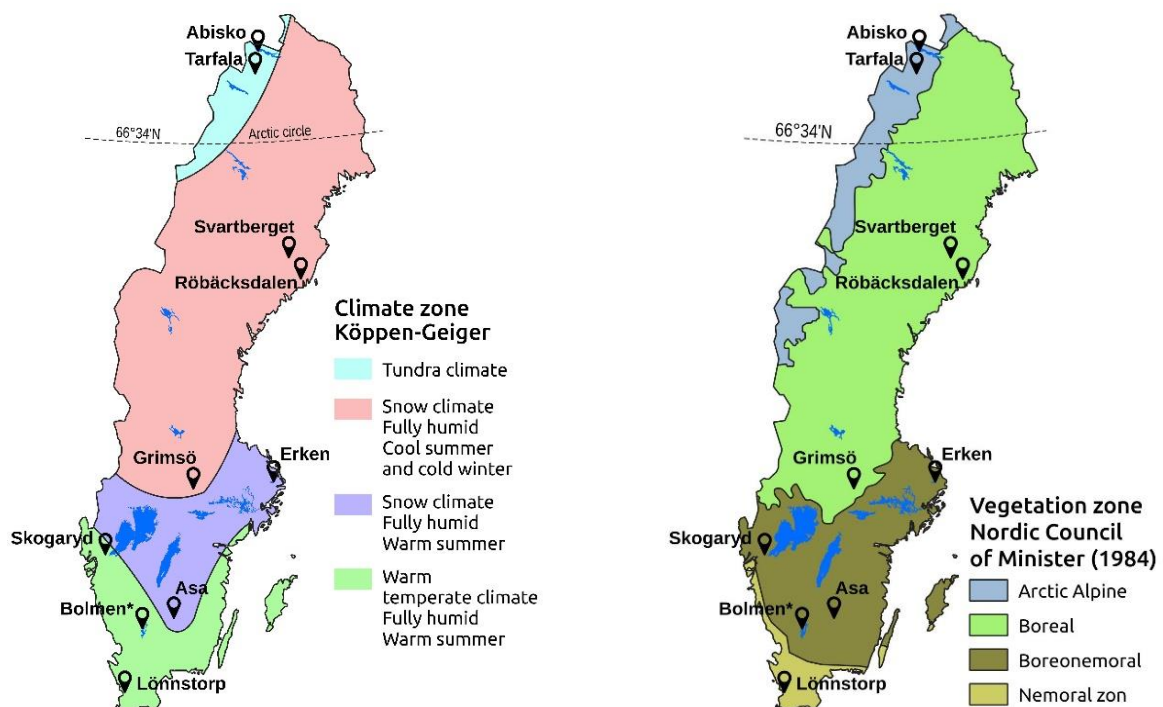


Figure 1. SITES research stations are distributed across Sweden and encompass different ecosystems and climatic zones.

The infrastructure is supported by the Swedish Research Council (VR) together with the organizations running the stations, i.e. the University of Gothenburg, the Polar Research Secretariat, the Swedish University of Agricultural Sciences (coordinator), Stockholm University, and Uppsala University. In

addition to the organizations listed SITES Spectral is coordinated using services offered by Lund University.

SITES offers all researchers, regardless of organizational affiliation, the opportunity to use SITES as a resource in their research. SITES promotes high-quality research through active support by offering access to the station facilities, data, and subject experts on top of practical support.

More information about the infrastructure and the contributing stations can be found on the SITES website: <https://www.fieldsites.se/en-GB>

Twenty-twentyone marks the fourth year in the current five-year funding period from the Swedish Research Council ending in 2022. The 2021 operations were characterized by further developing and consolidating the five priority areas identified in the 2017 application, in short: (1) to make data available on the SITES Data Portal, (2) to increase the number of users, (3) to make scientific products visible, (4) to increase coordination and exchange between stations, and (5) to increase international visibility and cooperation with other infrastructures and networks. The report below describes how this was achieved.

1.1 The effects of Covid-19

The consequences of the ongoing pandemic affecting society as a whole have also impacted SITES activities during 2021 to a similar extent as 2020. This can be seen in the reduction of in-person station use and joint activities. Covid restrictions present a special challenge for a distributed research infrastructure that benefits from healthy community exchange and continuous communication. Holding regular workshops enabling knowledge exchange across stations, attendance at meetings and conferences as well as a daily presence at individual research stations were restricted. These restrictions put constraints on the development of most of the identified priority areas for the 2021 period, namely (2), (4), and (5). Despite restrictions, data collection by station staff and remote access for scientific projects could largely proceed as planned. Projects using remote access have increased during Covid, with 241 projects making use of this option in 2021 compared to 195 in 2020 and 158 in 2019. The number of remote user days is also at an all-time high of 3,404 user days, compared to 1,923 in 2020 and 2,367 in 2019. Some of this increase is the result of involvement in large international projects such as LifePlan which uses many remote user days. The focus on and the use of SITES data benefited from the pandemic and 4,594 downloads in 2021 prove the value of the e-infrastructure. This increase in data downloads shows that the infrastructure has a robust foundation and can function even in times characterized by unforeseen events and challenging circumstances.

1.2 SITESIII – continued funding (2023-2028)

The Swedish Infrastructure for Ecosystem Science (SITES) has now been awarded continued funding for the grant period 2023-2027, under the Swedish Research Council's (VR) call for research infrastructures of national interest. With the new funding, SITES can look forward to continuing operations during a third funding period where SITES will continue to promote high-quality research across Sweden linked to the research stations. In the coming funding period, SITES are expected to develop and establish a model for coordinated infrastructure operation with ICOS (Integrated Carbon Observation System) and ACTRIS (The Aerosol, Clouds, and Trace Gases Research Infrastructure) and engage internationally within the eLTER (European Long-Term Ecosystem Research) network. The

new funding will both secure long-term monitoring programs within the station network and enable the infrastructure to develop to meet the future needs of researchers and other stakeholders.

2 SITES research stations

2.1 Numeric summary of station activities

National research infrastructures with support from the Swedish Research Council, such as SITES, must report specific key figures for their activities. The definitions of the key figures were established by the Swedish Research Council prior to the reporting for the 2018 financial year and apply to scientific projects. This year (2021) marks the fourth year of reporting key figures in accordance with these definitions. In addition to the Swedish Research Council's key figures, SITES reports its own key figures for competence-building projects. This category includes courses, workshops, conferences, and study visits. Taken together, these key figures provide a picture of the added value that the SITES Stations provide for education, knowledge distribution, and research support to other sectors of society. The key figures are reported in Appendix 1.

Stations have different research profiles and the volume and breadth of operations vary, which strongly affects the key figures of the individual stations and makes cross-station comparison misleading. This annual report mainly summarized total figures for the entire SITES infrastructure. However, each stations' key figures are reported to the Swedish Research Council as well. The year 2021 was again a special year due to the pandemic. Therefore, it is difficult to evaluate and interpret the key figures in comparison with years reported prior to the pandemic, i.e. 2018 and 2019. Nonetheless, an interesting comparison can be made between the development of the two years before and during the pandemic.

In 2021 a total of 507 scientific projects (compared to 492 in 2020 and 515 in 2019) have received support from SITES. This amounts to a total of 16,938 user days in 2021 (14,198 in 2020, 16,831 in 2019). Among the user days, 20% were remote access, which means that work was performed on-site by the station staff. This is an increase compared to the 14% reported in both 2020 and 2019, as might be expected with the limitations placed on travel during the past year, and the time-intensive sampling associated with the LifePlan project. The number of projects on location in 2021, 388, is an increase from 2020, but a decrease from pre-pandemic numbers from 2019 (377 and 451 respectively). The total number of user days on location reflects this pattern with 13,534 user days in 2021, up from 12,276 in 2020, but still down compared to the 14,464 days on location reported in 2019.

Fifty-three projects used more than one station, which is an increase from 2020 and 2019 (50 and 30 projects, respectively). This represents a small but positive step towards the goal of increasing collaboration across stations. The number of projects tied to a thematic program decreased to 42 in 2021, down from 50 and 46 (in 2020 and 2019, respectively).

The number of unique users involved in scientific projects that have used any SITES station was 979 in 2021, down from 1,051 in 2020 and 1,210 in 2019. But the total number of unique SITES users when including participants from training development and outreach programs was a staggering 2,572 users. In 2021, 63 training development and outreach projects were carried out at sites stations (59 in 2020 and 171 in 2019). These projects had 1,881 unique users corresponding to 2,786 user days, compared to 553 users in 2020 and 4,964 in 2019, corresponding to 3,711 and 9,961 user days respectively. Skill-building projects were strongly affected by the pandemic as various restrictions made it difficult or impossible to travel to the stations.

SITES is a national infrastructure open to all researchers and offers access to the infrastructure according to the equal conditions principle. SITES is also actively working through outreach and distribution of information to create equal gender distribution among users and a globally diverse user base. In 2021, project leaders for reported scientific projects were from 40 different universities, including 10 Swedish universities, in addition to 28 other domestic and international research institutes and organizations such as SMHI and the British Antarctic Survey. These project leaders represent 18 countries (compared to 19 in 2020 and 17 in 2019).

2.1.1 Gender distribution

Of scientific project leaders, the percentage of female project leaders has stayed roughly the same in the past three years, but increased slightly to 36% in 2021 compared to 32% in 2020 but decreased since 2019 (39%). Among other participants, there was a decrease in the proportion of women to 27%, down from 29% in 2020 and 35% in 2019.

For scientific projects, there is a higher percentage of female (13%) than male (10%) junior project leaders, with a slight decrease from the 14% reported in 2020 and 2019. The number of senior female project leaders has increased to 23% from 18% in 2020 (though still less than the 25% reported in 2019). The large decrease in senior female project leaders during 2020, which has not completely rebounded, could in part be due to the Covid19 pandemic. The pandemic has had a disproportionately negative impact on female scientists who showed decreases in the number of posted pre-prints and initiated research projects during the pandemic compared to their male peers (Viglione, 2020). Even before the pandemic, the percent of senior female project leaders still lagged behind their male equivalents (25% female, 46% male in 2019) and this imbalance remains (23% and 18% female in 2021 and 2020, compared to 47% and 50% male in 2021 and 2020).

Within all projects (not limited to scientific projects), 67% of the project leaders were men and of the users whose gender was reported, 60% were men.

When examining project leaders of scientific projects within career stage, women make up 56% of all junior PIs (53% in 2020, and 59% in 2019), and 33% of senior PIs. Of the other users, 44% of junior infrastructure users were female and females make up 30% of the senior users. This reflects the larger pattern in academia of the “leaky pipeline” in which a high proportion of young academics are female but leave academia in higher numbers than their male colleagues, resulting in a higher proportion of senior male academics. With a distribution of both project leaders and infrastructure users that is broadly reflective of academia as a whole, in order to close the gender gap within SITES and achieve the gender balance strived for by the European Research Council, proactive steps may need to be taken in the future to attract projects led by female PIs and take other proactive measures to make SITES increasingly attractive as a resource for this user group.

*Please note that the percentages do not always add up to 100% due to a number of project leaders whose gender or career stage was not reported.

Viglione G. Are women publishing less during the pandemic? Here's what the data say. *Nature*. 2020 May 1;581(7809):365-7.

2.2 Research and development work at each station

A total of 238 peer-reviewed articles were published in scientific journals in 2021 (comparisons: 232 (2020), 204 (2019)). Published articles were divided into research fields based on SCB’s standard for the Swedish division of research topics. Biological Sciences (38.7%), Earth and related Environmental Sciences (35.3%), and Agricultural Sciences (15.1%) were the largest subject areas, but research conducted at the SITES Stations covers a much wider range of research areas (see Table 1). Abisko (72) and Svartberget (63) accounted for more than 56% of the total number of publications. The third-largest number of articles were published in connection to Grimsö (36). Ten articles acknowledged multi-station use. The section below highlights research activities conducted at SITES Stations during 2021.

Table 1: Distribution of SITES publications 2021 within various research subjects based on SCB’s standard for the Swedish division of research topics.

Research topic	Percent
1 Natural Sciences	79.8%
103 Physical Sciences	5.0%
104 Chemical Sciences	0.4%
105 Earth and Related Environmental Sciences	35.3%
106 Biological Sciences	38.7%
107 Other Natural Sciences	0.4%
2 Engineering and Technology	4.2%
207 Environmental Engineering	4.2%
3 Medical and Health Sciences	0.8%
303 Health Sciences	0.8%
4 Agricultural and Veterinary Sciences	15.1%
401 Agriculture, Forestry, and Fisheries	9.7%
402 Animal and Dairy Science	0.4%
405 Other Agricultural Science	5.0%

In **Abisko**, work on the installation of a new SITES Spectral mast on Stordalen Mire was conducted as the old mast fell over due to corrosion. The new prototype mast allows for a more robust installation on thawing permafrost and is therefore perfectly suited for the changing conditions on the mire system. Additionally, the system was modified and can easily be lowered, so sensor maintenance is possible without climbing the tower. The instrumentation was successfully tested in autumn 2021 and has since been part of the regular monitoring by SITES Spectral. The EMERGE (EMergent Ecosystem Responses to ChanGE) project continued on the Stordalen mire and required continuous maintenance support from the station staff. The project aims to improve the understanding of how thawing permafrost systems respond to climate change and subsequently cause climate change, with a focus on carbon cycling and microbial populations and communities. As part of the extensive lake sediment campaign, sampling was conducted at Lake Almborgsjön for long- and short core analysis. The station also took major steps to reduce its climate and environmental impact by replacing the direct electric heating with air source heat pumps and by installing solar panels. The work will continue into 2022. Furthermore, an electric car was purchased.

At **Tarfala** a change in the station’s leadership required a special focus on knowledge transfer for the long-term monitoring of the two thematic programs to be implemented, i.e. SITES Water and Spectral. The station staff successfully continued the monitoring in a winter and summer campaign. Constraints

due to the pandemic affected the remote station of Tarfala significantly and only limited staff and researchers were allowed to visit the station. The long-term glacier mass balance measurements continued for all Swedish reference glaciers.

Erken’s extensive lake monitoring continued throughout 2021 including a unique time series on ice cover, which began in 1940. Long-term physical and biogeochemical monitoring data from the lake was presented at the 12th Symposium for European Freshwater Science (SEFS) conference to showcase how this data can be used to calibrate and validate physical-biogeochemical models. Erken research station also supported a project that investigated spatial and temporal variation in surfactant composition in the lake and its effects on greenhouse gas emission using long-term micrometeorological flux observations. The station has also been part of the sediment campaign aiming to improve background data and contextual information for the lakes within SITES Water. At Erken short sediment cores were sampled and analyzed at the Department of Limnology, Uppsala University, along the transects used for monitoring GHG fluxes across the lake. In a project which uses several SITES Stations to look at interactions between particles and organic matter, soil samples were taken at the station. The station also started to participate in the sampling for the LifePlan project during 2021.

The two agricultural stations Lönnstorp and **Röbäcksdalen** began a new project ‘[Is plant establishment first come, first serve?](#)’. This multi-year experiment will test whether priority effects determine vegetation diversity at large spatial scales (in 100m plots). It will also test whether priority effects induce changes in higher trophic levels (macroinvertebrates) or belowground (using root cameras). Both stations started to participate in the sampling for the LifePlan project during 2021.

Lönnstorp also began a new three-year project [intercropping fava beans and peas](#). The goal of the project is to investigate whether intercropping of peas and fava beans can provide higher and more stable yields in organic production compared to the individual cropping of each. Another project that started in 2021, [NAPERDIV](#), is using the [SAFE](#) infrastructure at Lönnstorp. This project aims to introduce perennial grain crops as a nature-based solution for innovative and future-proof agricultural systems in Europe. The station also decided to start the process of building two irrigation facilities, one located at the Lönnstorp research station and the other located near the new organic experimental field. The hope is that these irrigation facilities will enhance the conditions for conducting relevant and interesting sustainable agricultural research at Lönnstorp.

Svartberget and Asa are both forest experimental parks where changes in vegetation, forest stands, and processes in soil, air, and water are studied in both basic and more practically oriented studies. Svartberget began field trials examining: [silviculture alternatives for the interior of northern Sweden](#). In total, 19 silvicultural trials will be established over a two-year period on forestland of varying fertility. For some trials, many years have passed since the actual felling. The aim is to study the long-term effects of tree species, soil preparation, reforestation method, and plant fertilization. Furthermore, the station participated in a project investigating soil organic carbon and nitrogen contents. The project also used the fixed installations of long-term micrometeorological flux observations (EC fluxes).

Asa continued with the long-term monitoring of forest phenology in 2021. Phenological observations at the station were done on birch, spruce, and pine trees as well as on bilberry and lingonberry bushes throughout the year. Therefore, shoot development, autumn leaf coloring, leaf falling, and flowering were followed. The monitoring program started in 2006. Despite restrictions due to the pandemic, the station was able to host a first forest excursion again which provided inside into “climate-adapted forestry” where more than 60 forest owners participated. Additionally, a pilot study together with SLU’s

Forest Damage Centre was started to sample and investigate damages caused by the bark beetle (Hylastes). Asa and Svartberget both started to participate in the sampling for the LifePlan project during 2021.

SITES forest research at Svartberget and Skogaryd was featured on [Swedish television](#). The science show, Vetenskapens värld, included footage from Svartberget and Skogaryd as well as researchers connected to SITES.

At **Skogaryd** station change in leadership took place in 2021. But besides this change, the long-term monitoring whole system approaches continued regularly. At the beginning of 2021, new methods in form of georadar technology were tested to complement the sediment mapping campaign, which was conducted in autumn 2020 at the station. The station hosted a large campaign where different methods to measure greenhouse gas lake flux were tested and compared including various national and international partners. The project also served as a platform to conduct a video campaign to produce a SITES Water introduction video, which is planned to be published in 2022. In addition, the station provided the base for a hands-on meeting for the strategic research area BECC (Biodiversity and Ecosystem Services in a Changing Climate) in which researchers from Lund University and the University of Gothenburg collaborate to strengthen the knowledge base of multiple research disciplines within both organizations. The station started to participate in the sampling for the LifePlan project during 2021.

The research at **Grimsö** mainly concerns the ecology and management of large mammals and their relationship to forestry and agriculture as well as the interests of various societal actors. In addition to a large number of external research projects at the station, an important line of business consists of the annual collections of about 20 long-term data series. These are dominated by species abundance and distribution data, but also include phenology (plants and migratory bird species), habitat data, and weather data. In 2021, the long-term monitoring continued including the work collecting data for the LifePlan project. Grimsö also became part of the project looking at interactions between particles and organic matter in soils, which uses several SITES Stations.

2.3 Scientific courses and meetings

One of SITES' strategic goals is for the stations to be used to an increasing extent for scientific courses and meetings. This creates opportunities to show the participants what opportunities for research SITES offers and increases knowledge about the research that is currently conducted within the SITES infrastructure. It also promotes contacts and networking between researchers and station staff. The pandemic limited the number of courses and meetings that could be held on-site in 2020 and 2021, so some were postponed to the future while others were conducted remotely.

Some in-person activities that were able to go forward were:

- The 18th Krycklan symposium at Svartberget. This symposium brings together people involved in the Krycklan Catchment Study and other interested researchers to hear more about the activities taking place in the catchment and to gain insight into the most recent research. In 2021, 30 participants attended the symposium in person.
- Grimsö hosted 13 participants from Sweden, Norway, Finland, and Denmark (researchers, local authorities, and other stakeholders) for a workshop within the joint project to combat the spread of alien invasive species, for example, the raccoon dog, in Scandinavia.

- Lönnstorp hosted many classes during 2021. The agroecology and horticulture students from SLU focused on the SITES agroecological field experiment during their visit, while students from Lund University toured the field and performed eddy covariance measurements at the station.
- Erken Laboratory hosted 662 students from 12 primary and high schools from around Uppsala and Stockholm counties for their Water Days program. During the visit, the students learn about how research in aquatic ecosystems is conducted and had the opportunity to learn about lake ecology and identify some key species found in the lakes.

Courses or course elements within the universities' undergraduate and master's programs are usually given by the host organization, but external universities also use the stations for courses.

2.4 Collaboration with the local community

One goal in SITES' strategic plan is for the research performed at SITES stations to be used in the community and be communicated with the public outside of academia. One way to involve the community is for collaborators from outside of academia to be involved in projects conducted at the research stations. In 2021 there were 38 projects where the project leader was not associated with a University.

These projects include:

- Abisko research station hosted filmmakers from BBC during their filming for the second season of the nature documentary series, Frozen Planet.
- Grimsö is a part of a national project where authorities and researchers collaborate to develop new techniques to reduce wildlife collisions on roads and railroads. They host meetings at Grimsö, and production of wildlife scaring devices has started at the station. This project brings together many stakeholders including the Swedish transport administration (Trafikverket), county administrative boards, and others.
- SMHI collaborated with Röbbäcksdalen field station to collect data on precipitation and radiation

2.4.1 SITES-related research in the media

Like previous years, several local, national, and international media organizations have run stories about SITES or the research conducted using data from the SITES infrastructure. This media attention increases the general public's knowledge about research and other activities conducted by SITES. Below is a list of stories that received media attention during the past year.

- SVT: [Vetenskapens värld: Slaget om skogen](#)
- SVT: [Uppdrag gransking - Klimatbomben](#)
- SVT: [Kebnekaise – åtta årstider](#)
- TV4: [Två tredjedelar av världens glaciärer borta vid seklets slut](#)
- Sveriges Radio: [Sommar i P1 - human induced changes in the Arctic](#)
- Dagens Nyheter: Debatt – [“Utsläpp av växthusgaser I Sverige underskattas kraftigt”](#)
- The Guardian: [Climate crisis is suffocating the world's lakes, study finds](#)

2.5 Associated Stations

The **Bolmen** Research Station has been associated with SITES since 2018 through a collaboration agreement between SLU and Sydvatten. Bolmen's participation in SITES mainly applies to the thematic program SITES AquaNet, but the station is planning to participate to a wider extent in the infrastructure in the future. In 2021, discussions began about the best approach for implementing the SITES Water program at Bolmen.

Additionally, the station participated in a GLEON project focusing on dissolved organic matter (DOM) content in lakes globally using ultra-high-resolution mass spectrometry during 2021. Furthermore, the station is part of the LifePlan project, which started in 2021, looking at global biodiversity using a variety of different methods including insect and spore traps, audio recordings, etc. Besides the international engagement, Bolmen also further developed collaborations on a regional scale. Two new projects are using lake Bolmen as a testbed, one study looking at the Lake Wave Climate, investigating the hydrodynamics of waves and their effect on water quality, as well as a Water workshop joining forces of major companies involved in the drinking water supply to develop methods to enable online water quality monitoring, called the VA SYD Källby workshop and NSVA RecoLab.

The station's leadership regularly participates in the SITES communication activities and joins the monthly station manager forum.

In 2021, the station continued to host the competence building project Think H2O!, which provided education to nearly 900 high school students in Covid-19 secure ways over five weeks in September and October. The project highlights the value of water and increases young people's awareness, knowledge, and understanding of water-related issues and challenges. In the project, all young people and teachers have been informed about SITES and its activities. Think H2O! works for a lasting and long-term commitment by developing existing collaborations and involving new partners and experts on sustainability and water-related topics. Since the project started in 2014, almost 5,000 students and teachers have been educated at Think H2O!.

3 SITES Thematic Programs

3.1 SITES Water

SITES Water builds a unique long-term, well-coordinated measurement program where hydrological, physical, chemical, and biological parameters within lakes and streams are measured. Based on this 'backbone' infrastructure SITES Water provides data and facilities to address a broad range of scientific questions relevant to the scientific community. There are several types of data collected within SITES Water divided into six layers.

- Layer 1: Background information
- Layer 2: Water balance
- Layer 3: Physical variables
- Layer 4: Chemical variables
- Layer 5: Biological variables
- Layer 6: GHG and C fluxes



All layers are split into base and advanced level where base levels apply to all stations, and advanced apply to some and are usually a result of already ongoing programs and built on previous knowledge at the station.

3.1.1 Included stations

SITES Water includes seven of SITES stations: Abisko, Asa, Erken, Röbbäcksdalen, Skogaryd, Svartberget and Tarfala.

3.1.2 Activities in 2021

The monitoring program has been conducted according to plan despite Covid-19 restrictions which affected the work at the stations due to limited user access as well as physical staff presence at the station. As for 2020, the annual in-person technician meeting had to be canceled, still, the monthly virtual meetings took place during the entire year. The central coordination team met weekly.

The work during 2021 focused heavily on implementing the SITES Data Portal structure at all stations for data types produced from Layer 1 to 4. Furthermore, the background information Layer 1 has been implemented on the data portal for all participating SITES Stations to provide users with contextual information across the infrastructure. The eDNA material collected by the stations in Layer 5 has been partly processed and contact with the external data host SBDI has been made to further develop data and metadata sharing capability for genomics data in the future. Data produced within Layer 6 is planned to be implemented in the SITES Data Portal during 2022. Micrometeorological data produced within the advanced Layer 6 at certain SITES Stations (i.e. Erken, Svartberget, and Skogaryd) will be structured with the help of data coordination of ICOS following similar data structures.

In an additional effort, SITES Water continued the work on an elaborate sediment sampling campaign aiming to improve background data and contextual information for the lakes within SITES Water. The result is important for the gas flow measurements that take place in Layer 6. Sediment sampling of Erssjön (Skogaryd station) and Feresjön (Asa station) were already carried out in late autumn 2020, but the campaign continued at Lake Erken and Almborgsjön (Abisko station), where short and long sediment cores were sampled, during 2021. The short cores were analysed in cooperation with the Department of Limnology at Uppsala University and the data is scheduled to be published on the SITES Data Portal in 2022. Long cores have been stored for future analysis.

The new automatic gas flux chamber system developed by Linköping University, Department of Thematic Studies (TEMA), was tested and then used at Lake Följesjön during 2021. In a large sampling campaign that included various national and international partners, different methods for measuring GHG lake flux were tested and compared. The long-term test of the automatic flux chamber system will be carried out during 2022.

SITES Water Stations with lakes have participated to various degrees in projects initiated by the Global Lake Ecological Observatory Network (GLEON) and all stations contributed to a large scale project focusing on tracking seasonality in dissolved organic matter (GLEON DOMseasons) aiming to better understand how the origin and composition of dissolved organic matter vary through time using ultra-high-resolution mass spectrometry and its association with biogeochemical data collected from high-resolution sensors (provided by the SITES Water program).

Furthermore, a video campaign has been conducted at the Skogaryd station during autumn 2021 to document and ultimately produce a SITES Water introduction video, which is scheduled to be published in spring 2022. Additional pre-existing video material has been collected from other stations to complement the efforts and guarantee representation of all stations within SITES Water.

3.1.3 Plans for 2022

The monitoring program within SITES Water will be conducted as in previous years. Making the monitoring data openly available on the portal will continue to be a high priority, now with a strong focus on the layer 6 data. The annual technician meeting will be held at Erken in March for both SITES Water and SITES AquaNet as it is vital to develop competence for the personnel at the stations working with these structures and data to deliver a state-of-the-art measurement program. A special aim for this workshop will be to address the Layer 6 GHG data and to identify alignments between the thematic programmes to further strengthen the infrastructure and collaborations across stations. The new automatic gas flux chamber system will be tested at Lake Erssjön (Skogaryd Station) in 2022.

The handover of the coordination of SITES Water from 2023 and onwards from the Skogaryd Station to SITES centrally will be conducted by having the new coordinator Dr. Marcus Wallin co-sharing the coordination work during 2022.

3.2 SITES Spectral

3.2.1 Included stations and data management

SITES Spectral covers all SITES stations. Six stations (Asa, Lönnstorp, Röbbäcksdalen, Skogaryd, Svartberget, and Tarfala) participate fully in all activities, while the others participate in parts of the program. Measurements are made at the stations and are sent to SITES Spectral Thematic Centre (SSTS) in Lund for quality control and the development of quality-controlled data that can be used for further analyses. Data storage and backup are done in Lund and all generated products are accessible via the SITES data portal.



3.2.2 Activities in 2021

In 2021 SITES Spectral focused on increasing the amount of collected and processed data, as well as on improving the data quality and metadata labeling. The drone program was revised, in accordance with the plan, to reduce the number of multispectral flights and instead focus on increasing the area flown with RGB cameras. While aiming for a reduction in the number of multispectral flights, a large number of multispectral flights were still performed in 2021. Some stations purchased new drones since the old ones were reaching end-of-life. A broken mast for fixed spectral sensors in Abisko was replaced with a new one. Testing of a new brand of spectral sensors to replace broken ones was initiated during winter since some stations were experiencing problems with their equipment. The security level of the data transfer system was increased and a new uploading portal was launched. Furthermore, work was initiated to improve automatic data transfer to Lund from cameras and fixed installations. Discussions about how involvement in CEOS Land Product Validation work can be developed have been on hold since it will mainly be relevant during SITES III when new equipment for measurement of fAPAR will be installed.

The development of satellite-based products on vegetation phenology and productivity was tested for a few stations and presented during the annual conference.

Major tasks completed in 2021 include:

- The decision to conduct one UAV campaign per year with a larger spatial footprint than in previous years where SITES Spectral helped to support stations with flight planning.
- In 2021 a total of 5,534 images were collected from RGB flights and 56,358 images from MSP flights. These images come from flights at all stations except Abisko, where no flights were conducted this year.
- Data from all 11 RGB flights have been processed, creating 3 data levels (i.e., UAV Orthomosaics, Digital Elevation Models, and Point Clouds).
- All data from the 216 MSP flights has been processed and is in the process of being uploaded to the SITES server.
- All PhenoCam data until mid-2021 was processed during 2021. The rest of the images are currently being processed.
- Fixed sensor datasets up to 2020 from all SITES stations were processed. This helped to provide valuable insights on sensor performance. The processed data is in the quality flagging stage. Uploading these data is one of the major tasks of 2022.
- Prototypes of satellite data (NDVI, PPI, seasonality products) were generated for a couple of stations and were presented at the annual meeting. The satellite data products for each station will be produced in 2022.
- The station interaction program was carried out. It has been necessary to organize this sort of interactive program at least once a year to better understand the issues that stations are facing. It provides a forum to discuss the quality of the data the stations have collected over the years and allowed for discussion of how to enhance the quality of data acquisition moving forward.

3.2.3 Plans for 2022

The most important planned activities for 2022 are:

- Development of satellite data products on vegetation phenology and productivity for all stations. The data include seasonal trajectories of an index responsive to photosynthesizing leaf area, and several phenological parameters (start of season, end of season, productivity, amplitude, etc.). The data originate from Copernicus HR-VPP and this will provide analysis-ready data in the Swedish reference system for an area extending around each station ca. 20-30 kilometers, at a spatial resolution of 10 meters. The information will be invaluable for upscaling vegetation processes resulting from both climatic conditions and human activities. Also, stations with otherwise limited involvement in SITES Spectral (e.g. the lake stations) will be covered. Abiotic variables (e.g. snow and ice) will be considered for some stations, but vegetation products will be prioritized this year.
- Development of full quality labeling of all data products. The work was initiated in 2021 but needs to be fine-tuned and tested.
- Documentation of all procedures, both for internal use and for generating product user manuals.
- Ensuring automatic download of camera and fixed sensor data and a visualization page for immediate display of all fixed sensor data. This is to ensure that the station staff can check data

quality regularly. This work is done in collaboration with ICOS Sweden who are developing the framework of the routines for SITES Spectral.

- Continue discussions with ICOS Sweden on the inclusion of ICOS Hyltemossa and ICOS Norunda in SITES Spectral. Discussions on the inclusion of spectral measurements from the Lanna agricultural field station are also ongoing.

3.3 SITES AquaNet

3.3.1 Included stations

SITES AquaNet includes four SITES stations: Asa, Erken, Skogaryd, and Svartberget, as well as the SITES associated station, Bolmen.

3.3.2 Activities in 2021

In 2021 one of the primary focuses of SITES AquaNet was the planning of a coordinated experiment with the opportunity for transnational access within the EU project AQUACOSM-plus in 2022.



Several workshops and meetings were also organized, starting with a kick-off workshop in May 2021 and followed by three follow-up meetings. At these meetings topics and experimental designs for the AquaNet/AQUACOSM-plus TA experiment were discussed and developed with participants linked to both the SITES AquaNet and AQUACOSM-plus consortia. A particular part of the discussion was focused on identifying topics related to grand challenges in Ecology that can be addressed using mesocosm link to a webinar series that was organized within the AQUACOSM-plus project. These discussions resulted in a list of possible experiments that can be done using the SITES AquaNet infrastructure. For 2022, it was decided that the experiment will investigate the effects of climate-driven variability in organic matter run-off on lake communities. A TA call for that experiment was opened in December. At the same time, the first tests began on organic matter extractions from natural and commercial peat soils that will be needed for the planned manipulation.

The effects of Covid-19 continue to be felt within the SITES AquaNet infrastructure with an experiment originally scheduled for 2020 being postponed once again. Delays and restrictions due to Covid are also a likely explanation for the lack of applications for the third annual call for projects using the SITES AquaNet infrastructure which was issued at the beginning of 2021. The hope is that as restrictions are lifted and scientists are able to meet again in person, this will trigger the planning of the type of large collaborative projects that AquaNet was designed for.

A scientific article describing the AquaNet infrastructure was published in *Limnology and Oceanography methods* (DOI: [10.1002/lom3.10432](https://doi.org/10.1002/lom3.10432)). In addition, 2 publications from the 2017 test experiments were published (DOI: [10.1111/1365-2745.13804](https://doi.org/10.1111/1365-2745.13804), DOI: [10.1002/ecy.3283](https://doi.org/10.1002/ecy.3283))

The work with the previously developed maintenance plan for the sensor system was continued and several stations (Erken, Skogaryd, and Bolmen) send their Trilux sensors to the company in the UK from where the sensors were purchased to be upgraded and recalibrated.

3.3.3 Plans for 2022

The main activity for 2022 is the AQUACOSM-plus TA experiment that is scheduled to be run for 6-7 weeks in the period from July 1st until August 18th. As we can already foresee that due to uncertainties around the opportunities for international travel we will not have enough applicants to run the experiment in all 5 lakes, we will continue with the planning for additional experiments in 2023.

The Trilux sensor upgrade will also be completed for the two remaining stations (Svartberget and Asa) and plans for purchasing spare sensors and parts and new instrumentation for the SITES-III phase will be initiated. This work will be planned in detail at the joint SITES Water/AquaNet workshop held at Erken in March 2022.

4 Data handling

The SITES Data Portal is in full operation since autumn of 2019 and the number of data sets and different data types openly available is continuously increasing. In 2021, the data portal has become the main data repository in use for all participating research stations. These efforts led to a significant increase in the number of downloads from 1122 (2020) to 4728 (2021). The data portal contains data sets from meteorological stations located at all SITES Stations, thematic program data from SITES Water, Spectral, and AquaNet, as well as station-specific data series. Continuous efforts are made to increase the usability of the data repository both for users of the data and data providers, i.e. the station staff and central data management. In line with this, staff at each station are trained to both make use of the e-infrastructure and provide support to additional users. Key components of the data management are communicated broadly internally, i.e. metadata assignments, data documentation with the overarching goal to follow the FAIR principles (Data that is Findable, Accessible, Interoperable, and Reusable). The ICOS team based at Lund University, who host the SITES Data Portal, support SITES with system development and advice, and training in data management. Regular monthly data management meetings between station staff, the system developers, thematic program leads and the central coordination office is a forum to discuss common protocols, best practice solutions, idea exchange for further developments and improvements of the data services and discussions on individual requests.

Open access to the SITES Data Portal can be found under the following link:

<https://data.fieldsites.se/portal/>

The SITES Data Portal uses persistent identifiers (PIDs) to enable traceability of individual data sets; each dataset uploaded on the portal is counted as a data entry. The number of data entries also includes updates of existing data sets. The front-page data catalog lists the latest version of each data entry, previous versions of updated data sets are linked on the metadata information page for individual data entries. Therefore, the total number of data entries is higher than the number of data sets listed in the data catalog. Download statistics from the data repository consider all existing data entries as seen in Figure 2.

The download statistics from the SITES Data Portal can be tracked including filter options for country code, station, and time period by visiting the data portal statistics website:

<https://data.fieldsites.se/stats/>

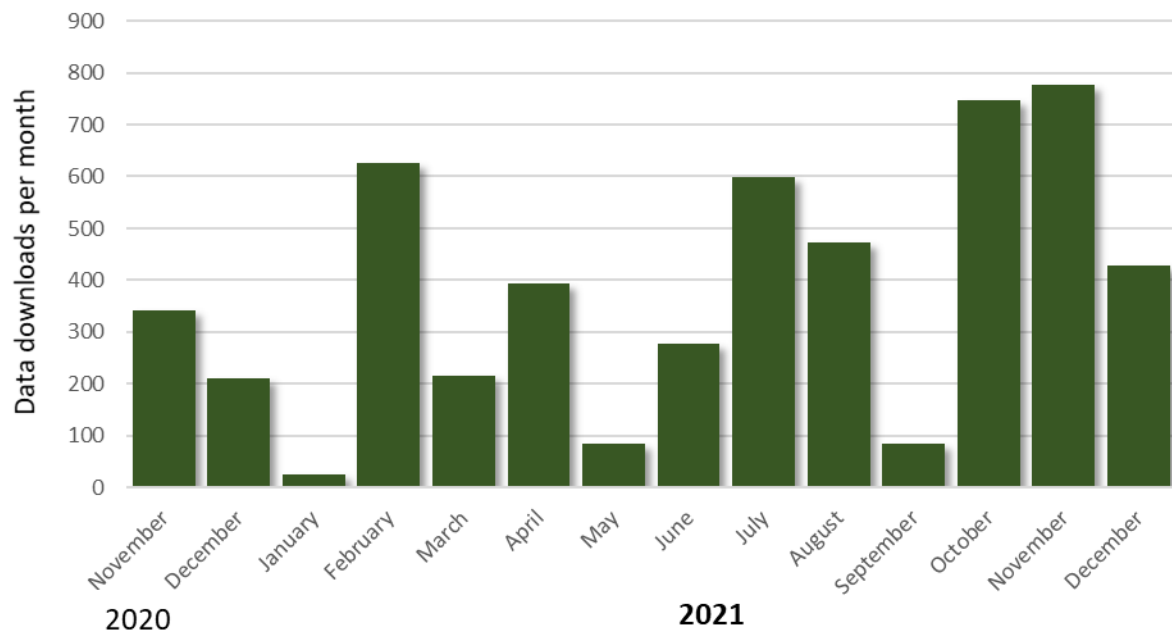


Figure 2: Total downloads per month from the SITES Data Portal between November and December 2020 and January to December 2021.

The highest number of individual data downloads occurred in November 2021 with a total number of 777 single downloads. As of December 2021, datasets had been downloaded from 21 different countries distributed globally. Most of these datasets were downloaded from European countries with the highest number of downloads from Germany (n=3,634) followed by Sweden (n=742). A station-specific overview of individual downloads over the year 2021 is provided in Table 2).

Table 2. Number of data downloads per station during 2021.

Data Portal Downloads - 2021	
Station	Downloads
Abisko	524
Asa	405
Bolmen	134
Erken	451
Grimsö	6
Lönnstorp	242
Röbäcksdalen	229
Skogaryd	796
Svartberget	763
Tarfala	1 178
Total	4 728

The e-infrastructure was marketed by highlighting individual, significant data sets or larger data deliveries spanning multiple stations in the bi-monthly newsletter. The SITES Data Portal was presented at several scientific meetings e.g. the Swedish Oikos Society, the strategic research area BECC (Biodiversity and Ecosystem Services in a Changing Climate), and at department seminars. In addition, research publications were advertised using SITES data and acknowledging the use of the infrastructure and VR funding. The marketing efforts will continue in 2022 and throughout the next funding phase.

A dialog and information exchange was initiated between the SITES coordination office and the eLTER data management leaders with the aim to align future metadata harvesting and data delivery services between the two infrastructures. Based on this, best practices in data management were discussed in several data sessions during the eLTER fall meeting in 2021. Metadata harvesting tools based on Json-Ld scripts were also provided to the Swedish National

Data Service (SND) in spring 2021 to ensure data representation and links to the SITES Data Portal from their research database catalog.

Time was also spent establishing a robust metadata sharing service with the INTERACT network for three of the SITES Stations (Abisko, Svartberget, and Tarfala). The stations listed have collaborative agreements with the INTERACT network and are required to offer a metadata sharing service on the virtual single entry point (<https://dataportal.eu-interact.org/>) for open access to monitoring data from all INTERACT stations. The SITES e-infrastructure was able to fulfill the requirements and tools were provided to the system developers to enable metadata harvesting from the SITES Data Portal and the respective stations. The engagement will continue in 2022 and throughout the next funding phase and will prepare SITES for involvement in similar metadata harvesting initiatives in the future.

In addition, the development of INTERACT / SITES-GIS continued. This is a system designed for use by researchers applying for station access and tracks research activities and projects carried out at the stations. Several meetings were held throughout the year between the system administrators at Umeå University and the central coordination office to adapt the project application form to standardize the data collection with the quantitative information needed to compile the yearly report to VR. The updated project registration is scheduled to be published in spring 2022 and is planned to be implemented by all SITES stations that same year.

5 Leadership and coordination

The SITES management function is briefly described below along with a brief account of how it has developed and changed over the year in response to the infrastructure needs.

5.1 SITES consortium

SITES is run jointly by SLU, the University of Gothenburg, Stockholm University, and Uppsala University, as well as the Swedish Polar Research Secretariat. The terms and conditions for the collaboration are defined in a consortium agreement with an added opportunity for the SITES partners to provide input on strategic matters (business plan, budget, associations, and agreements) during yearly meetings with the Partner Organization Advisory Board. This advisory group also advises on strategic plans, the decommission plan as well as the appointment of the director and steering group. This model for engaging the SITES partner organizations ensures that the SITES operations are aligned with the strategic planning of the partner organizations and as such facilitates the long-term strategic joint development of the infrastructure together with the organizations that co-finance and support the work.

In 2021, the Partner Organization Advisory Board met twice virtually on 28/01 and 28/10. Representatives of the principals were Maria Knutson Wedel (Vice chancellor of SLU, chair of the meeting), Ingela Dahllöf (Vice Dean of the University of Gothenburg), Katarina Gårdfeldt (Director, Swedish Polar Research Secretariat), Anders Karlhede (Deputy Vice chancellor of Stockholm University) and Anna Qvarnström (Vice Dean of Uppsala University). From SITES, the director Stefan Bertilsson, deputy director Blaize Denfeld and coordinator Holger Villwock participated, along with Sofia Wretblad from SLU's management office. Usually, the chair of the steering group participates as well, but due to illness, Barbara Ekbom (deceased Professor Emeritus at SLU) could not attend the extra meeting held in January. This meeting focused on the appointment of the steering group (appointment period: 2021-03-01 - 2024-02-29) and discussions on the VR application which was submitted to the Swedish Research Council on the 10th of February 2021. The regular meeting held in October focused

specifically on the business plan, budget, and the conditions for the next funding period (2023-2028) after a positive funding decision from VR. The meeting provided valuable advice for the upcoming dialog meeting with VR and gave their full support to the business plan and budget which were submitted to VR after final approval by the steering group.

5.2 Steering group

The SITES steering group is appointed by SLU with the charge and mandate to oversee and lead the activity of the infrastructure in line with the governing documents. The former steering group has had its mandate from 2018-03-01 to 2021-02-28 and had the following members:

- Johan Bergh, Linnaeus University
- Sebastian Diehl, Umeå University (Vice Chair)
- Barbara Ekbom, Professor Emeritus, SLU (Chair)
- Anders Hedenström, Lund University
- Mari Källersjö, Gothenburg Botanical Garden
- Inger Kappel Schmidt, University of Copenhagen
- Hanna Silvenoinen, Norwegian Institute for Nature Research

Sadly, Barbara Ekbom the former chair of the steering group passed away on the 7th of February 2021 after a period of illness. She will be sorely missed and the SITES community will remember her commitment to the infrastructure and the guidance and support she provided.

The current steering group has its mandate from 2021-03-01 to 2024-02-29 and consists of the following members:

- Johan Bergh, Linnaeus University
- Jan Bengtsson, SLU
- Anna Gårdmark, SLU (Chair)
- Anders Hedenström, Lund University (Vice Chair)
- Jan Karlsson, Umeå University
- Inger Kappel Schmidt, University of Copenhagen
- Hanna Silvenoinen, Norwegian Institute for Nature Research.

In 2021, the steering group met eight times. The higher frequency of meeting compared to previous years were both to get the new steering group going and to handle several important topics and decisions, i.e. application submission for SITESIII and eLTER engagement. Similar to 2020, all meetings have been conducted as half-day virtual meetings due to the pandemic situation, except the meeting held during the “all-hands” meeting on the 1st of December in Sigtuna when travel and meeting restrictions were temporarily lifted. Regular meetings took place on the following dates: 14 Jan, 23 Feb, 13 Apr, 9 Jun, 1 Sept, 24 Sept, 9 Nov, 1 Dec.

5.3 Scientific Advisory Board

Due to the increasing demand for large-scale infrastructure access and broad support across multiple stations, SITES has taken initial steps to establish a separate, independent Scientific Advisory Board (SAB) to assist with evaluation and prioritization. The SAB consists of 3-5 prominent scientists and will provide strategic advice to the Steering Group on prioritization of infrastructure access and strategic

development and will be maintained during the next project phase. The SAB and the Steering Group should have one joint meeting per year, with additional meetings when called for. The appointment for the SAB is three years with possible reappointment for a second three-year period. A group of candidates was identified by the director with additional input from the steering group and station managers. The following SAB members were appointed by the steering group with their term starting January 2022:

- Mari Källersjö, Gothenburg Botanical Garden (Chair)
- Göran Ståhl, SLU
- Klaus Steenberg Larsen, University of Copenhagen
- Gerlinde de Deyn, Wageningen University & Research
- Kathleen Weathers, Cary Institute of Ecosystem Studies

5.4 Station manager forum

The SITES operational group includes the nine SITES station managers, the SITES thematic program leaders, the director of associated station Bolmen, and the SITES secretariat. The constellation has met regularly during the year on ten occasions (i.e. every month except for the holiday periods in July and August). Due to the ongoing pandemic, all meetings have been organized as virtual meetings, except when the group met during the “all-hands” meeting held in November at Sigtunahöjden (Sigtuna).

In 2021, a change in leadership at two of the SITES stations occurred, i.e. Tarfala and Skogaryd. At Tarfala station Nina Kirchner became station director and Per Holmlund became vice station director when Gunhild Ninis Rosqvist stepped down as station director after leading the station’s operations for 16 years. This year, Tobias Rütting also assumed responsibility for leading the operations at Skogaryd research station. The former station leader, Leif Klemedtsson, still maintains his engagement with the station in an advisory role and as a leader for the thematic program SITES Water during 2022.

The station manager forum is a regularly occurring meeting that serves to distribute information and is a platform for discussion and an important activity for communication between the SITES secretariat and the field research stations. These meetings enable coordination, operational planning, and consensus building on common strategic goals within the infrastructure.

5.5 Secretariat

The secretariat's task is to operationally lead the infrastructure and ensure that the SITES operations are conducted in accordance with the strategic goals and the steering group's decisions. Like previous years, the secretariat's functions are co-localized at the Department of Aquatic Sciences and Assessment (SLU, Uppsala) under the leadership of director Stefan Bertilsson, also working as Professor at the same department. The director’s position covers 50% of a full-time position.

The director is assisted by a secretariat consisting of a deputy director (100%), a coordinator who leads the work with SITES data management (100%), a communicator (20%), an economist (25%), and an international coordinator (10%) who also leads LTER Sweden. In addition to the staff employed at SLU, the system development and maintenance of the SITES Data Portal, corresponding to 50% of a full-time position is commissioned to the ICOS Carbon Portal hosted by Lund University. Until March 2021, external communication services were purchased from Trossa AB. Additionally, the steering group has approved strategic initiatives that included the temporary employment of two environmental analysis assistants who have contributed to the work with the geographical background description of the

stations, data mobilization as well as completion of a sediment mapping campaign for two lakes within SITES Water, which was started in 2020.

6 Communication

External communication about SITES and the station's activities and the opportunities offered to the research community is conducted both centrally at the secretariat and at the stations.

The SITES website <https://www.fieldsites.se/en-GB> is the central information platform. During 2021, the page was updated, filled with new content and continuous work on improving the layout has been conducted. The number of unique visitors continued to increase from 6,939 (2018), 8,017 (2019), 9,106 (2020) to a major increase of 29,100 unique visits in 2021. News about SITES, the stations, and the thematic programs are regularly published on the website. Weekly news was posted on the website throughout 2021 and the number of items stayed consistent compared to the previous years from 22 (2018), 34 (2019), 56 (2020) to 49 in 2021.

In 2021 six newsletters were sent to a broad target group consisting of internal recipients such as station staff/managers and the leadership group as well as externals consisting of key researchers associated with SITES, colleagues at the station's departments, and department listservs. SITES offers an open subscription option on the website as well as within each newsletter and this also includes easy access to unsubscribe from the send list. Each newsletter contains, among other things, status reports from the stations highlighting ongoing activities, interviews with staff working in SITES or at a station, a description of a dataset from the SITES Data Portal, and a list of new publications. The Mailchimp platform was used again this year to send out the newsletters and at the end of the year, the newsletter had 154 subscribers.

SITES also uses several social media platforms to engage with a wide network of potential users and to adapt to the state-of-the-art information flow within research. The current platforms used are: Facebook (98 posts in 2021), LinkedIn (64 posts in 2021), and Twitter (72 posts in 2021). The two latter were started in the spring of 2021 and especially the Twitter account showed the highest increase in popularity with over 200 subscribers at the end of 2021. SITES AquaNet and Lönnstorp research stations also have Twitter accounts as part of their science communication strategies. The social media platforms are mainly used to repost weekly news published on the SITES website, but also to share and repost job advertisements within the scope of SITES and to highlight news posts from SITES collaborators, i.e. individual researchers and research networks.

In order to highlight researchers who have used SITES and their research, a series of interviews was continued in 2021, in which the researchers were interviewed about their experiences using SITES and the research they conducted at one or more stations or through the thematic programs. Two interviews were conducted in 2021, the first with Cecilia Palmberg from the Swedish University of Agricultural Sciences, the second with David Bastviken from Linköping University. One interview was published on the website and the second interview is planned to be published in spring 2022 in the context of a larger effort to highlight the research and monitoring of greenhouse gases conducted within SITES Water. The interview series will continue in 2022.

During autumn 2021, a video campaign initiative was started to produce communication material in the form of short 2-3min videos. Staff from the SITES Secretariat worked together with an external filmmaker and conducted a campaign at the Skogaryd station in early September to document an

ongoing collaborative field experiment that engaged one British and multiple Swedish universities. Video clips including interviews and fieldwork were recorded and then used to produce short movies for SITES Water and a “Research Highlight” featuring David Bastviken and his integrative monitoring of greenhouse gas fluxes using several of the SITES stations. The material is scheduled to be made publicly available in 2022.

In order to communicate the opportunities offered by the infrastructure, SITES normally participates in meetings, conferences, and similar forums relevant to potential users of the infrastructure. Due to the pandemic, most of the meetings that SITES planned to attend in 2021 were again canceled. Still, the SITES secretariat virtually interacted with international networks and collaborative projects by participating in workshops and meetings linked to eLTER (Mars meeting), the NordicTestbed network (Introduction of SITES), and INTERACT (Virtual Access Point Workshop).

To complement the monthly meetings of the SITES operational group, data management meetings were conducted with participation from all stations and the data portal system developers under leadership from the coordination office. Additional technical meetings of SITES staff coordinated by the thematic program leads enable further knowledge exchange and cross-station coordination.

In March 2021, the engagement with Trossa AB as the external communication office ended. The need for increased and more frequent communication efforts that were more tightly linked with the secretariat operations led to the engagement of an internal communicator based at the Department of Aquatic Science and Assessment to support the communication tasks (20% commitment).

The highlight of the year took place in form of the “all-hands meeting” at the conference venue Sigtunahöjden at the end of November 2021. The pandemic situation at that time allowed for larger in-person gatherings in Sweden and SITES didn’t miss the opportunity to finally meet with representatives from all stations, the steering group, secretariat, and invited guests. Three days of fruitful discussion were instrumental in paving the way for implementing the next phase of SITES.

7 International collaborations

7.1 LTER Europe

In 2021, SITES has continued its participation in the two Horizon 2020 projects eLTER PPP and eLTER PLUS which are developing a European research infrastructure for ecosystem research and monitoring, based at field stations in LTER Europe. The governance body in the developing RI is the Interim Council, consisting of ministry representatives from all partner countries. In Sweden, this is delegated from the ministry to the Swedish Research Council with a further mandate to SITES. At first, Sweden was represented by former SLU Pro Vice-Chancellor Kevin Bishop. However, after Kevin Bishop was elected chair of the Council, Sweden is now represented by the SLU Vice-Chancellor Maria Knutson Wedel and Sofia Wretblad.

Within the two H2020 projects that aim to develop the RI, members of the SITES secretariat have been given the tasks of e.g. developing structures and standards for data management and modeling, developing a Human Resources strategy, as well as establishing a strong forum for Site and Platform Coordinators across this emerging network of European LTER stations. This is an opportunity to develop our international network and ensure that we are well aligned with developments taking place at the European level, a mission that is fully in line with SITES’ strategic plan. The secretariat has also

promoted the selection of some SITES stations as “Master Sites” in the planned research infrastructure. All stations in SITES are members in LTER Sweden and thereby also in LTER Europe and receive continuous information from the leaders of eLTER and are also invited to join the forum for station representatives, topical working groups, and the biannual eLTER meetings.

7.2 AQUACOSM-plus

Through Uppsala University, SITES AquaNet participates with all its five AquaNet stations including the associated station Bolmen in the EU infrastructure project [AQUACOSM-plus](#). AQUACOSM-plus aims to develop coordination and sharing of leading European mesocosm infrastructures and provides SITES with excellent opportunities for skills exchange and development as well as the opportunity for international researchers and students to participate in experiments conducted within SITES AquaNet. As part of this project, coordinated experiments with funding for transnational access will take place in 2022 and 2023 at the SITES AquaNet stations with ample opportunities for attracting new users, forging new collaborations, and highlighting the capabilities within SITES AquaNet.

7.3 LIFEPLAN

[LIFEPLAN](#) is a larger international project funded by a European Research Council Synergy grant that aims to map biological diversity on a global level by a combination of spatial biodiversity inventories and long-term biodiversity time-series observations. SITES participates by hosting and operating sample collection programs at seven of the research stations and the associated station Bolmen. The project will provide a foundation for establishing and expanding future biodiversity research within SITES with links to similar measuring stations and time series from ecosystems around the world. The sampling campaign was initiated in 2021 and all participating SITES stations are now delivering samples and automatically collected images and acoustic data to the project coordination office in Uppsala.

7.4 Other

In addition to the major infrastructure projects highlighted above, SITES participated in several other international networks and projects or contributed with infrastructure to support international collaborative research efforts. SITES has for example partnered with the Global Lake Ecological Observatory Network (GLEON) in several projects and during 2021 the SITES lake stations (Erken, Asa, Skogaryd, Abisko, Svartberget, and Tarfala) collected samples for a project aiming to analyze the seasonal variation in dissolved organic matter composition (DOM) on a global scale. In addition, Erken supported several additional GLEON projects including, for example, two projects that use zooplankton and water chemistry data from the lake monitoring program to study zooplankton as ecological indicators of ecosystem change and spatial as well as temporal changes in zooplankton biodiversity on global scales.

SITES has a longstanding collaboration with ICOS. One aspect of this is the operation and development of the SITES data portal but co-localization of infrastructure at several SITES stations shared technology development in micrometeorology and shared installations (e.g. masts) are other examples. Recently a third related infrastructure (ACTRIS; Aerosol, Clouds, and Trace Gases Research Infrastructure) was funded by the Swedish Research Council with additional apparent synergies, co-localization, and collaborative opportunities. While contact has already been established between SITES-ICOS-ACTRIS in the form of strategic discussion meetings and a joint workshop organized in late 2021, these efforts

will be intensified in the coming years and are in line with conditions from VR, will involve jointly developing a plan and vision for intensified infrastructure collaboration and integration.

8 Financial reporting

The funding for SITES comes partly from an infrastructure grant awarded by the Swedish Research Council (21,448 kkr per year), and partly from equivalent or larger co-funding from the owners of the participating research stations in accordance with the funding decision. The budget distribution between the participating organizations and stations (Table 3) is defined in the ratified consortium agreement. The stations vary in their history, organization, and mission and therefore there are large differences in the relative contribution of SITES activities and capabilities to the total station operations ranging from 100% of the activities to including only certain parts of the station activities.

The financial report includes both the central coordination functions within the secretariat and the SITES activities at the individual stations for the year 2021. It is subject to audit by an external accredited auditor to fulfill the requirements for an auditor's certificate.

The negative financial results for five of the stations and also for the infrastructure combined (Table 3) reflect an increased level of co-financing by the partners that is needed to maintain strategically important activities and programs at the SITES stations. The minor negative balance for the secretariat was caused by increased investments in data support and other centrally covered services to the stations including GIS tasks, sediment analyses and technician time.

Table 3: Financial reporting of grant funds and co-financing for SITES 2021.

Financial report SITES 2021 (kkr)				
Station	Costs	VR-funding	Budget	Result
<i>Abisko</i>	4 946	1 147	2 987	- 1 959
<i>Tarfala</i>	3 813	913	2 377	- 1 436
<i>Svartberget</i> ¹	11 577	3 810	8 651	- 2 926
<i>Röbäcksdalen</i>	3 083	1 256	3 269	186
<i>Grimsö</i>	1 712	808	2 105	393
<i>Erken</i> ¹	4 128	1 896	4 157	29
<i>Skogaryd</i> ¹	5 693	2 681	5 710	17
<i>Asa</i>	6 973	1 939	5 048	- 1 925
<i>Lönnstorp</i>	2 922	998	2 599	- 323
<i>Total SITES Stations</i> [*]	44 845	15 449	36 902	- 7 944
<i>Total SITES secretariat</i> ^{2,*}	6 776	5 999	5 999	- 777
<i>Total SITES stations and secretariat</i> [*]	51 621	21 448	42 901	- 8 721

^{*} For the total costs rounding causes slight differences in sums.

¹ The costs for thematic program coordination and data management are included in the financial report as follows: Erken 489 kkr for SITES AquaNet, Skogaryd and Svartberget 792 kkr each for SITES Water.

² The secretariat budget also includes costs for coordination and data management for the thematic program SITES Spectral at a total cost of 1 386 kkr which is allocated to Lund University (not a consortium member).

Appendix 1 – Key figures

Table A1: Project data key numbers for SITES scientific projects from 2021, 2020, and 2019.

Scientific projects	2021	2020	2019
Total number of projects	507	492	515
Home institution of the project ¹			
<i>Host organization</i>	324	328	298
<i>Organization within the consortium</i>	24	25	33
<i>Other Swedish Universities and academic institutions</i>	59	77	90
<i>Public organization</i>	2	4	3
<i>Other organization (private association or commercial enterprise)</i>	13	11	11
<i>International organization</i>	44	47	80
Projects linked to thematic programs or that use multiple stations			
<i>SITES Water</i>	28	29	35
<i>SITES AquaNet</i>	2	6	9
<i>SITES Spectral</i>	12	15	2
<i>Other projects that use multiple SITES stations</i>	53	50	30
Type of access ²			
<i>Total number of days used</i>	16 938	14 198	16 831
<i>On location - number of projects</i>	388	377	451
<i>On location - number of user days</i>	13 534	12 276	14 464
<i>Remote access ³ - number of projects</i>	241	195	158
<i>Remote access ³ - number of user days</i>	3 404	1 923	2 367
<i>Data downloads – number of projects</i>	348	379	289
<i>Data downloads – number of downloaded datasets</i>	4 594	1 897	2 592

¹ Home institution for the project is determined by that of the PI

² A single project can have both days on location and remote access.

³ Remote access means that the work was performed by station personnel

Table A2: User data key numbers for SITES Scientific projects in 2021, 2020, and 2019.

Scientific projects	2021	2020	2019
Users ⁴			
<i>Total number of unique users</i>	979	1051	1 210
<i>Number of unique project leaders</i>	304	295	335
<i>Number of other unique users ⁵</i>	675	756	875
Project leaders - split by gender and career stage			
<i>Female - junior</i>	39	40	48
<i>Female - senior</i>	71	53	83
<i>Male - junior</i>	31	36	33
<i>Male - senior</i>	144	148	153
<i>Unspecified gender or career stage</i>	20	17	18
Project leaders - home institute			
<i>Host organization</i>	180	148	135
<i>Organization within the consortium</i>	24	21	31
<i>Other Swedish Universities and academic institutions</i>	52	68	75
<i>Public organization</i>	1	4	3
<i>Other organization (private association or commercial enterprise)</i>	9	10	10
<i>International organization</i>	65	44	81
Other users - split by gender and career stage			
<i>Female - junior</i>	83	99	129
<i>Female - senior</i>	97	120	178
<i>Male - junior</i>	105	101	127
<i>Male - senior</i>	225	292	314
<i>Unspecified gender or career stage</i>	171	144	127
Other users - home institute			
<i>Host organization</i>	206	254	179
<i>Organization within the consortium</i>	94	108	93
<i>Other Swedish Universities and academic institutions</i>	112	134	162
<i>Public organization</i>	8	17	5
<i>Other organization (private association or commercial enterprise)</i>	17	19	9
<i>International organization</i>	253	224	427

⁴ Unique users are identified by station and summed across stations, meaning that the total number of SITES users and PIs will be slightly inflated if they are a part of projects at multiple stations.

⁵ Manual adjustments have been made within stations for users that were listed as both PIs and "other users". They have been counted just as PIs

Table A3: Key numbers for SITES training, development and outreach projects from 2021, 2020, and 2019.

Training, Development, and Outreach Projects	2021	2020	2019
Total number of projects	63	59	171
Home institution of the project ¹			
<i>Host organization</i>	20	30	66
<i>Organization within the consortium</i>	1	0	8
<i>Other Swedish Universities and academic institutions</i>	3	2	23
<i>Public organization</i>	36	21	58
<i>Other organization (private association or commercial enterprise)</i>	3	5	12
<i>International organization</i>	0	1	4
Type of access ²			
<i>Total number of unique users</i>	1 881	553	4 964
<i>Total number of days used</i>	2 786	3 711	9 961
<i>On location - number of projects</i>	56	56	168
<i>On location - number of user days</i>	2 646	1 510	9 798
<i>Remote access ³ - number of projects</i>	12	19	14
<i>Remote access ³ - number of user days</i>	140	2 201	163

¹ Home institution of the project is determined by that of the PI

² A single project can have both days on location and remote access.

³ Remote access means that the work was performed by station personnel