The Krycklan Catchment Study

A unique infrastructure for field-based research on hydrology, ecology and biogeochemistry

The Hitchhiker's Guide 5.5

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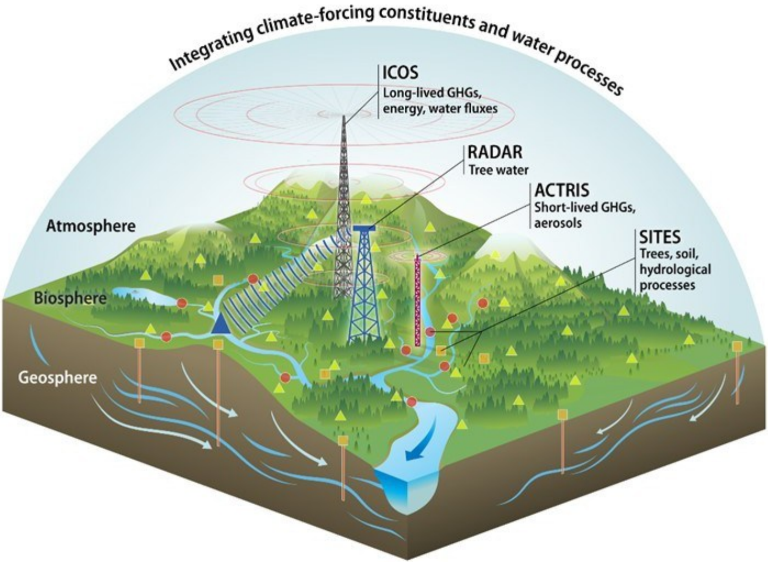
This field guide provides essential information for working within the **Krycklan Catchment Study (KCS)**. It outlines key research sites, infrastructure, and high-quality fieldwork across disciplines linked to their most recent publications.

Krycklan in a nutshell...

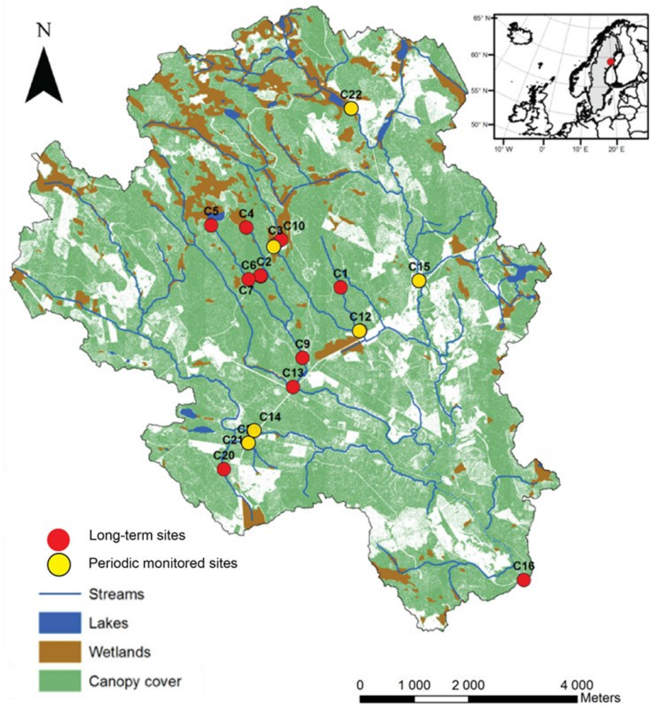
The 6,780-hectare Krycklan Catchment represents a natural mosaic of boreal landscapes—forests, mires, streams, and lakes—that typify 70% of Sweden's land area and reflect 30% of the world's forest cover. Krycklan is a core component of the Svartberget Field Research Infrastructure, operated by the Swedish University of Agricultural Sciences (SLU). In addition, the Svartberget field station oversees research at Degerö Stormyr, Rosinedal, Flakaliden, and Norrliden.

Currently, the site hosts more than 50 active research projects, engaging several hundred scientists from all major Swedish universities and over 30 countries worldwide. Approximately 50 PhD students conduct their research using the Krycklan research infrastructures.

Since its inception in 1910, Svartberget has been the foundation for over 1,000 scientific publications. Notably, 110 doctoral theses have been produced at the site—half of which are directly based on research within the Krycklan Catchment. The first PhD thesis from the site was published in 1923.



Overview of the Krycklan Catchment integrated with advanced research infrastructures:
***A)** ICOS – A 150 m tower measuring greenhouse gases, energy, and water fluxes;*
***B)** ACTRIS – Monitors aerosols, reactive gases, and cloud interactions;*
***C)** Radar Tower – A 50 m system quantifying forest evaporation and transpiration;*
***D)** SITES – Provides ecosystem monitoring across 11 sub-catchments, 200 groundwater wells, 120 sap flow sensors, and 500 permanent plots tracking soil–water–tree dynamics.*

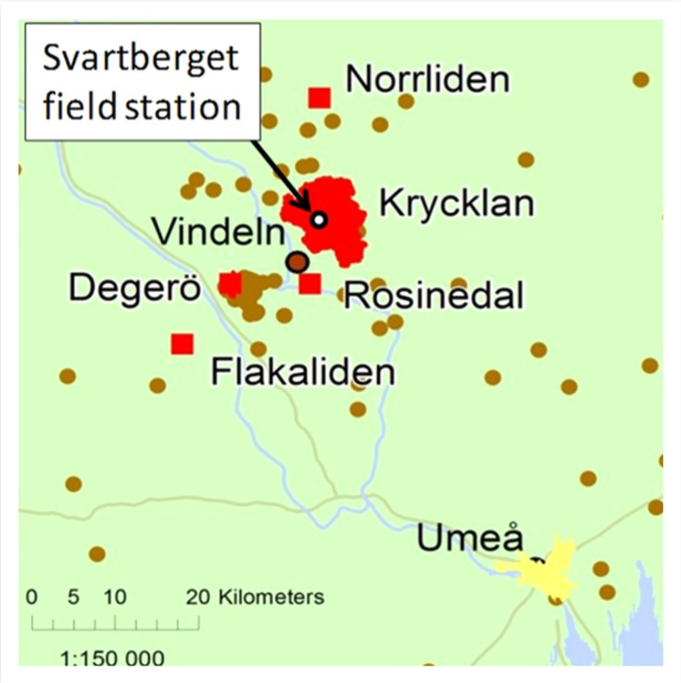


The table below shows the water monitoring sites within the Krycklan catchment area, along with comprehensive descriptions of their respective landscape characteristics. The periodically monitored catchments are shaded blue .

Site No	Full Name	Area (km^2)	Wetland (%)	Forest (%)	Lake (%)
3	Lillmyrbäcken	0.04	53	47	0
2	Västrabäcken	0.12	0	100	0
4	Kallkällsmyren	0.18	51	49	0
21	Lillsed	0.26	0	100	0
7	Kallkällsbäcken	0.47	19	81	0
1	Risbäcken	0.48	0	100	0
5	Stortjärnen Outlet	0.65	48	46	6
6	Stortjärnbäcken	1.10	29	65	4
20	Mulltjärnsbäcken	1.45	12	87	0
9	Nyängesbäcken	2.88	15	80	1
10	Stormyrbäcken	3.36	29	71	0
22	Bergmyrbäcken	4.91	29	68	3
12	Nymyrbäcken	5.44	19	81	0
13	Långbäcken	7.00	12	86	1
14	Åhedbäcken	14.10	7	91	1
15	Övre Krycklan	20.13	15	82	2
16	Krycklan	67.80	9	88	1

The Krycklan Catchment Study (KCS) is situated in northern Sweden, approximately 50 km northwest of Umeå.

It is also connected to the sites of the national forest production research network complied on the silvaboreal database. Silvaboreal is a metadata database containing most of the forestry field trials in Sweden. Currently, more than 3600 trials are registered in Silvaboreal, from 15 different organisations.



Location of the Krycklan catchment and other related study areas (red dots). The smaller dots (brown) are part of the national forest production research network consisting of 1400 sites across Sweden stored in the Silvaboreal database.

Key references

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Laudon H, Hasselquist M.E., Peichl M., et al. Northern landscapes in transition: Evidence, approach and ways forward using the Krycklan Catchment Study. Hydrological Processes 2021; 35:e14170. https://doi.org/10.1002/hyp.14170

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Swedish Infrastructure for Ecosystem Science

SITES (Swedish Infrastructure for Ecosystem Science) is a nationally coordinated research infrastructure supporting terrestrial and limnological field studies. It comprises nine research stations across Sweden, including Svartberget/Krycklan, strategically located to represent the country's diverse landscapes and climatic regions. These include agricultural areas, forests, mountainous regions, wetlands, various types of inland waters, boreal catchments, and tundra ecosystems.

SITES provides access to state-of-the-art facilities, field sampling equipment, and a wide range of data generated through long-term installations and observations. Access is open to all researchers on equal terms, regardless of institutional affiliation.

The initiative is funded by the Swedish Research Council and five partner institutions: the University of Gothenburg, the Swedish Polar Research Secretariat, Stockholm University, Uppsala University, and the Swedish University of Agricultural Sciences (SLU), which also hosts and coordinates the SITES network.

Many of the infrastructure elements described in this guide are also present at other SITES stations as part of the **SITES Water** program.

SITES

Read more here

Left: Locations of research stations within SITES

SITES AquaNet

This is a standardized infrastructure for national and international researches to run mesocosm experiments in lakes at Asa, Erken, Skogaryd, Svartberget and Bolmen field stations.

Mesocosm enclosures: Each site is equipped with a jetfloat deployed in Stortjärnen with 20 polyethylen cylindrical enclosures experimental manipulations.

Sensor measurements: The exper imental facilities have a sensor and datalogging system to measure in each mesocosm real-time environmental parameters.

Standardized sample collection and analyses: Each station is equipped with field equipment for sample collection and access to cold storage, freez- ing rooms and laboratory facilities. There is connec- tion to laboratories for further sample analyses at the SLU.

Research topics: Biodiver sity-functioning-stability relationships, community ecology, ecological stoichiometry, food web interactions, benthic-pelagic dy- namics, biogeochemistry (e.g., nutrient cycling), land-water-air gas exchange, cyanobacterial blooms and global change research.

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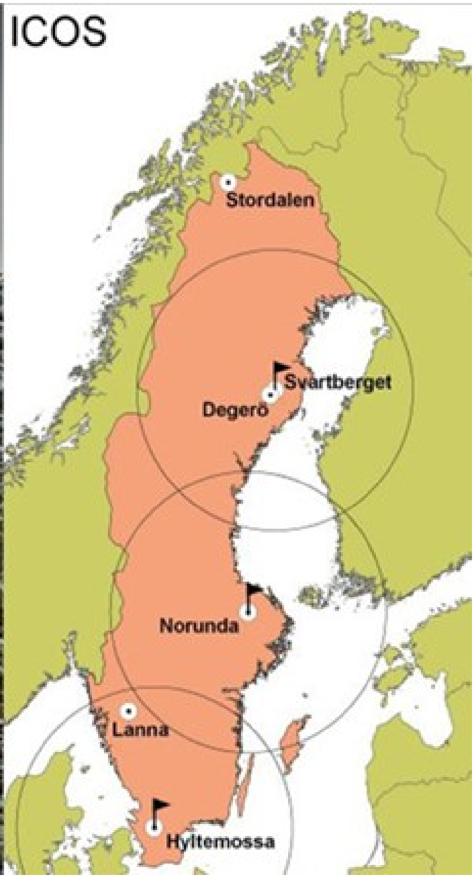
ICOS - Integrated Carbon Observatory System

ICOS is a European research infrastructure for quantifying and under- standing the greenhouse gas balance of the European continent and of adjacent regions. ICOS collaborates with nationally operated measurement stations in 17 European countries. ICOS Sweden consist of three atmospheric, six ecosystems and one ocean station. ICOS in Vindeln combines atmospheric and forest ecosystem site at Svartberget and one mire ecosystem site at Degerö stormyr.



Tall Tower-Svartberget

The ICOS Svartberget station, located in the Svartberget Experimental Forest in northern Sweden, is a combined atmospheric and ecosystem research site within the European ICOS network. Established in 2011 and officially labeled in 2019, the site is situated in a 1,076-hectare boreal forest that has supported ecological research for over a century.

A 150-meter tower continuously measures greenhouse gases (CO_2, CH_4, CO), water vapor, temperature, and radiation across multiple heights, providing data on both local and regional scales. Nearby, ecosystem fluxes of CO_2, H_2O, and energy are monitored using eddy covariance, alongside detailed measurements of soil, canopy, and meteorological conditions. The station offers a rare infrastructure setup ideal for long-term environmental monitoring, with all data openly accessible through the ICOS Carbon Portal.

Read more here

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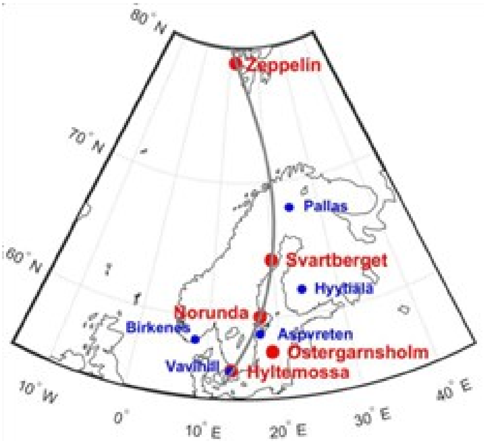
Martínez-García, E., Nilsson, M.B., Laudon, H., et. al., (2025). Drought response of the boreal forest carbon sink is driven by understorey–tree composition. Nat. Geosci., 17(3), pp. 197–204.

ACTRIS (Aerosols, Clouds, and Trace gases Research Infrastructure)

ACTRIS is part of the Swedish Aerosols, Clouds, and Trace gases Research Infrastructure (ACTRIS Sweden) which aims at producing long term high quality observations of shortlived climate forcers (SLCFs) and other relevant atmospheric pollutants. Aerosol particles, as SLCFs in general, have a short residence time in the atmosphere, typically from hours to weeks, which differentiates them from longlived greenhouse gases (LLGGs).

The short lifetimes of aerosol particles make their concentrations highly variable in time and space, and their evolution involves atmospheric chemical and physical processes occurring on very short timescales.

ACTRIS is colocate with the ICOS and observations are made in a coordinated and standardized way along a south-north (and hence anthropogenic pollution and climate) gradient.



BorealScat-2 RADAR Tower

Krycklan now houses another RADAR tower, where high-quality radar and forest water measurements are collected over timescales from hours to years. Forest transpiration is studied using radar tomography, which is directly sensitive to water content throughout the vertical extent of the forest. The availability of a reference ET dataset together with high temporal resolution radar measurements enables the development of the first-ever methods for estimating ET from radar observations. Together, these radar towers contribute to broader ecosystem research initiatives, including ACTRIS and ICOS, helping improve our understanding of boreal ecosystem water exchange, climate interactions, and the integration of in situ and remote sensing data.

More information can be found on the website : www.borealscat.se

The **BorealScat-2 radar tower** rises 50 meters above the boreal forest and is equipped with advanced synthetic-aperture radar (SAR) sensors operating across P-, L-, C-, and soon X-bands. It captures high-resolution, sub-hourly observations of canopy backscatter, providing data for monitoring forest moisture dynamics and modeling evapotranspiration (ET). By combining radar measurements with drone surveys, lidar scanning, and soil moisture monitoring, researchers can connect detailed forest hydrology to satellite observations.

Key references

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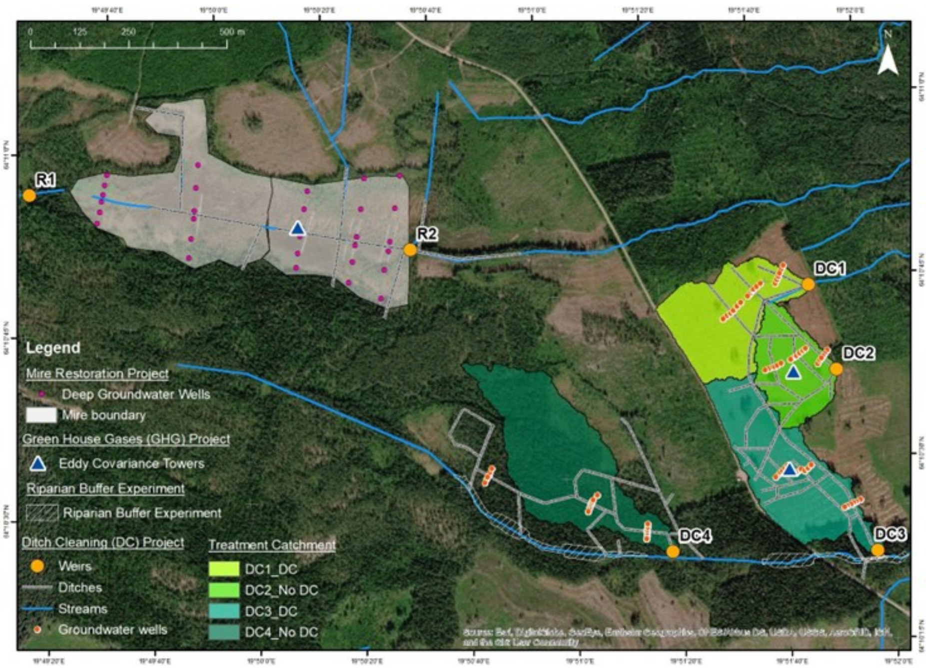
Trollberget Experimental Area (TEA)

Millions of hectares of northern peatlands were drained for forestry, which has increased forest productivity in some areas, but not all. The future fate of these drainage ditches can be to:

> **a) clean them to ensure continued drainage,**
> **b) hydrologically restore them to a more natural state, or**
> **c) leave them alone**

In fall of 2018, six stations were added to the Krycklan water quality monitoring network in a side-by-side comparison of these three different management options with the goal of determining their effects on water quality and quantity. We call this area "Trollberget" and it began with the EU LIFE program's GRIP on LIFE Integrated Project that includes demonstration areas for the restoration of an unproductive drained peat-land and best practices for cleaning of forest ditches.



Above: *Map showing the location of experimental sites where hydrological restoration has been carried out at R1 and R2, ditch cleaning at DC1 and DC3, and control sites (no intervention) at DC2 and DC4.*

Experiments	Site	Hydrological station	Treatment
Restoration	R1	53	Hydrologicaly Restored
	R2	54	Hydrologicaly Restored
Forestry Ditch management	DC1	58	Clear cut+ Ditch Cleaned
	DC2	59	Only clear-cut (Control)
	DC3	60	Ditch Cleaned
	DC4	57	Only Clear Cut (Control)

Ditch cleaning was carried out using a standard excavator in line with Swedish Strategic Management Objectives. Restoration followed best practices: cutting remaining mire trees, using them to build dams, and filling ditches with on-site peat.

The project has expanded to include research on forestry practices such as harvest methods, riparian buffer zones, and their environmental impacts covering greenhouse gas emissions, carbon and water cycling, and biodiversity.

We monitor groundwater levels, discharge, and runoff water quality at six outlet weirs, measuring parameters such as nitrogen, carbon, suspended sediments, pH, conductivity, CO2, methane, isotopes (18O, deuterium), ions, fluorescence, and mercury (total and methylated). Greenhouse gas and carbon balances are tracked using eddy covariance towers and chamber measurements.

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Zannella, A., Eklöf, K., Hasselquist, E.M., Laudon, H., Garnett, M.H. & Wallin, M.B. (2025). Changes in aquatic carbon following rewetting of a nutrient-poor northern peatland. J. Geophys. Res. Biogeosci., 130(4), Article e2024JG008565.

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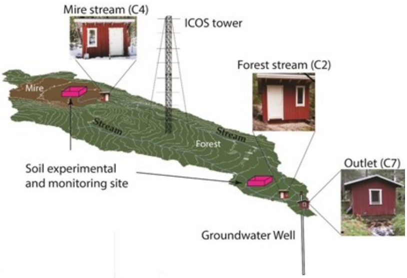
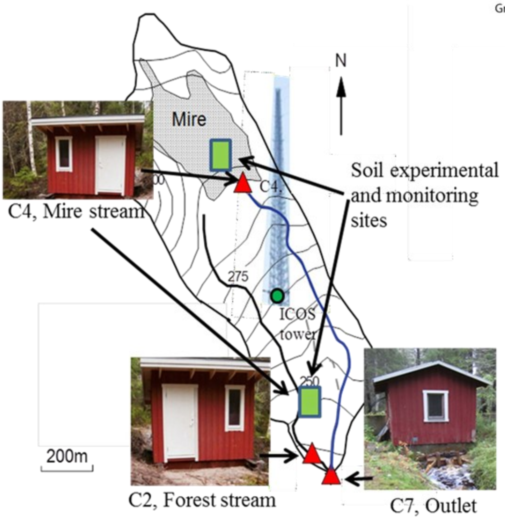
Skogssällskapet GRIP on LIFE Life NATURA 2000 Umeå Universitet Water JPI HOLMEN Länsstyrelsen Västerbotten FORMAS Kempestiftelserna SKOGSSTYRELSEN SLU

The Svartberget Catchment



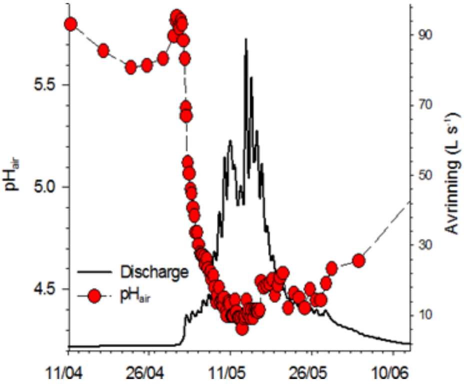


The Svartberget catchment is a unique natural laboratory for understanding boreal ecosystems, climate change impacts, and sustainable land management through integra-ted, long-term research.

Above: *The Svartberget catchment (C7) is the centre of Krycklan showing the different rese-arch infrastructures co-located in the same catchment*

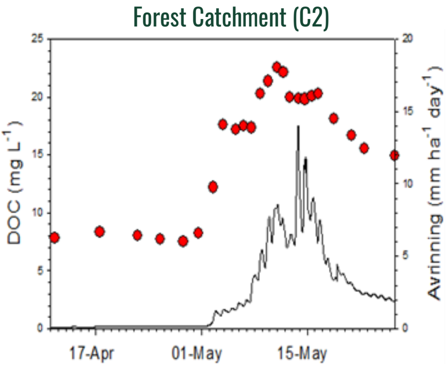
The catchment with many names (Svartberget, Nyänget, SVW, C7) is where it all began in 1979. It is also the heart of much of the current research on the contrasting hydrological and biogeochemical behavior of forested and mire catchments in Krycklan. The sites withing the catchment are strategically placed at the mire stream, forest stream, and the catchment outlet to study hydrological and ecological proces-ses. The Svartberget catchment also hosts the first soil experimental and monitoring sites that begun in 1997, including the S-transect and the “Russian wells”.

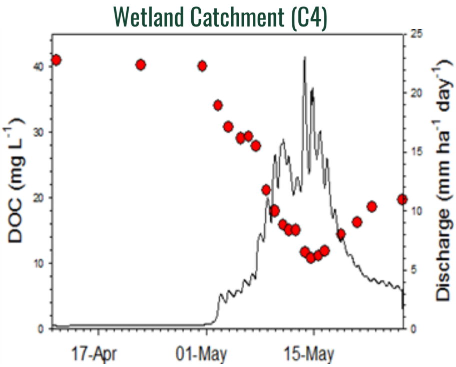
Its extensive dataset and integrated research approach make it a vital site for national and international collaborations.



Left: The decline in pH observed during the spring flood at site C7 and notably the increased concentration of dissolved organic carbon (DOC), which influences acidity through organic acid inputs and changes in water chemistry.

***Below**: The contrasting behavior of dissolved organic carbon (DOC) concentrations and fluxes observed between forested catchments and those dominated by wetlands, highlighting differences in carbon processing and hydrological responses.*





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Boreal stream stressors experiment

Ongoing climate change and land-use represent severe pressures on northern stream ecosystems which triggers many physicochemical changes, and when those changes exceed the range of background undisturbed conditions they become stressors for aquatic biota.

This project applys a unique integrative approach that combines experimental manipulations in mesocosms and natural streams with existing and new data collected in streams in connection to extreme events. The fluvial mesocosms built in 2020 will serve as the primary experimental platform.

A series of experiments will be conducted to manipulate key forestry-related stressors—such as variations in light, water temperature, turbidity, and chemistry—as well as extreme hydrological events like droughts and floods. These studies aim to understand how aquatic communities and ecological processes respond to and recover from such disturbances. Additionally, the dam infrastructure at the C5 lake outlet will be used to simulate drought conditions in a natural stream.

The KCS experimental facility includes 12 artificial stream channels (15 m long, 20 cm wide/deep) fed by water from a headwater stream. Grouped in triplets with separate inlets, the setup allows four-level water chemistry manipulation. Water temperature, substrate, gradient, hydrology, and light can also be controlled in replicated experiments.

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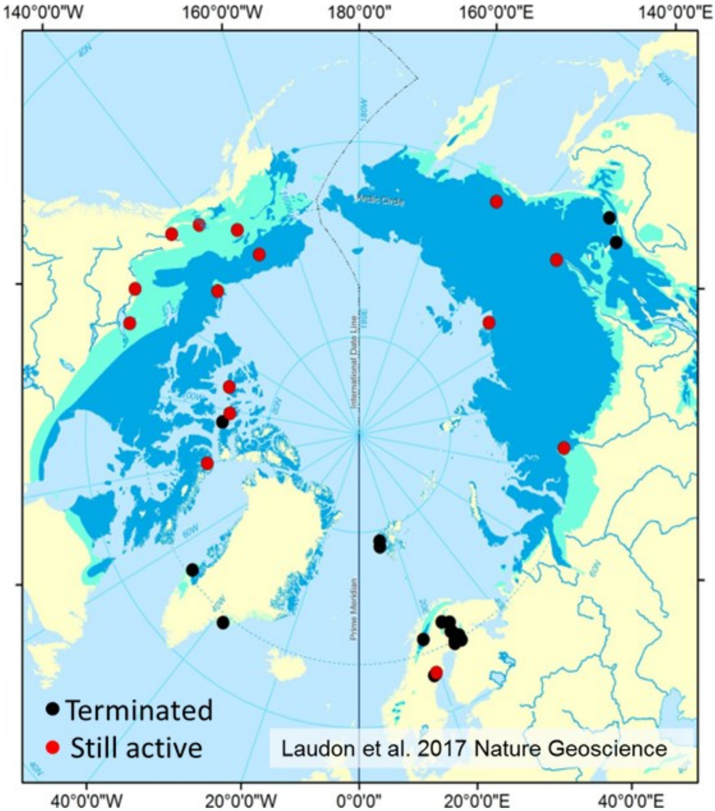
SAVE: Northern Long-term Research Catchments



Northern freshwaters are changing rapidly in response to global warming and human perturbation. Despite this there is an ongoing downsizing of small research catchments in the north. This is problematic as such research infrastructures are needed to understand and predict sustainable ecosystem services and social prosperity in this rapidly changing region.

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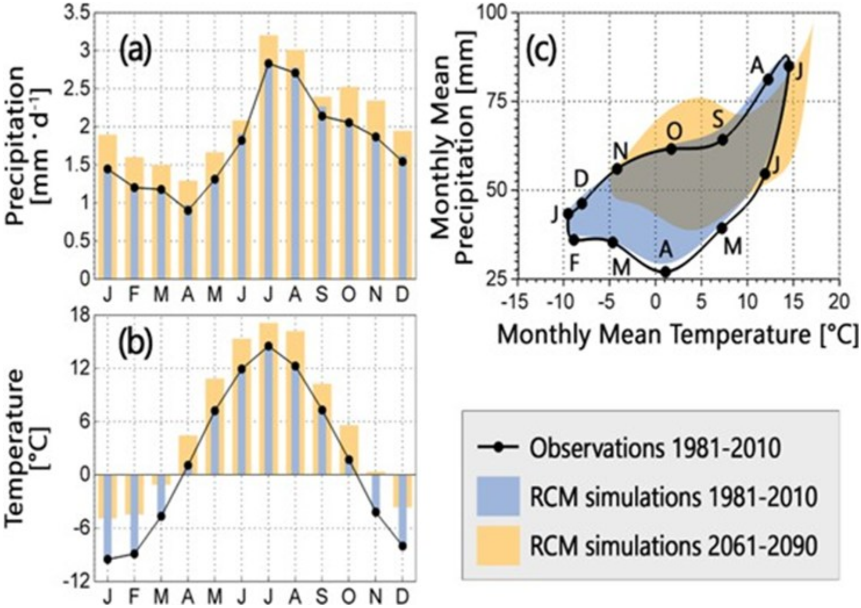
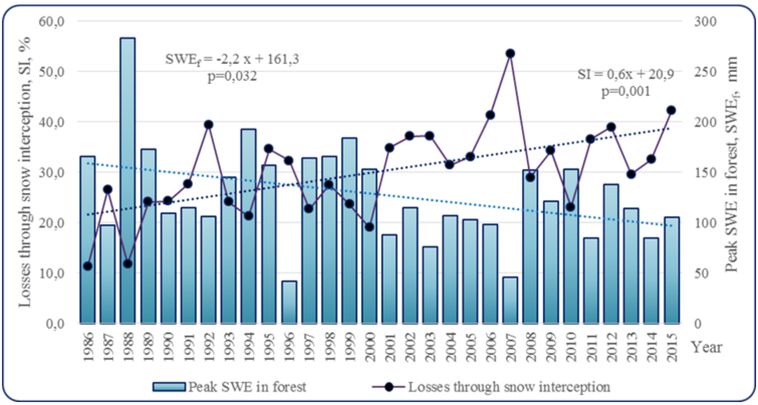
Krycklan and Climate



Above: *Seasonal Regional Climate Model (RCM) simulations in Krycklan of monthly (a) P and (b) T for reference period (blue) and future climate (orange) as well as (c) monthly P-T for reference(blue) and future (orange). Black dots connected with a continuous line are observations (Teutschbein et al. 2016).*



Above: *Development of snow water equivalents (SWE, bars and right axis) in spruce forest and changes in losses of water through forest canopy interception (connected points, left axis). (From Kozii et al. 2017).*

The Svartberget hygget station collects high -resolution meteorological data on precipitation, air temperature, vapour pressure, global radiation, and wind speed.

Measurements are taken every 5 seconds over a full 24-hour period (00:00–24:00), and daily values are calculated from these readings. This high-frequency sampling ensures accurate and detailed summaries of local weather conditions, supporting ecological monitoring, climate studies, and hydrological modeling.

The station is equipped with calibrated, automated sensors designed for long-term reliability in forested boreal environments.

Above*: One of 5 climate stations in the catchment, where the longest one has been running since 1981.*

Key references

Tiwari, T., & Laudon, H. (2025). Trends in hydroclimate extremes: How changes in winter affect water storage and baseflow. Hydrology and Earth System Sciences, 29(17), 4055–4067. https://doi.org/10.5194/hess-29-4055-2025

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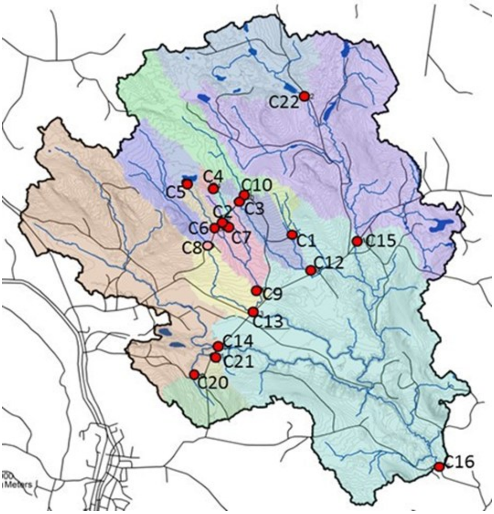
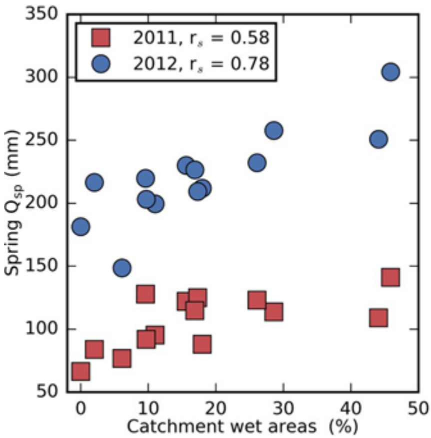
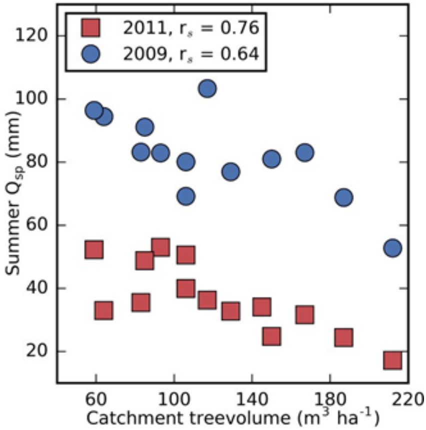
Krycklan and Hydrology

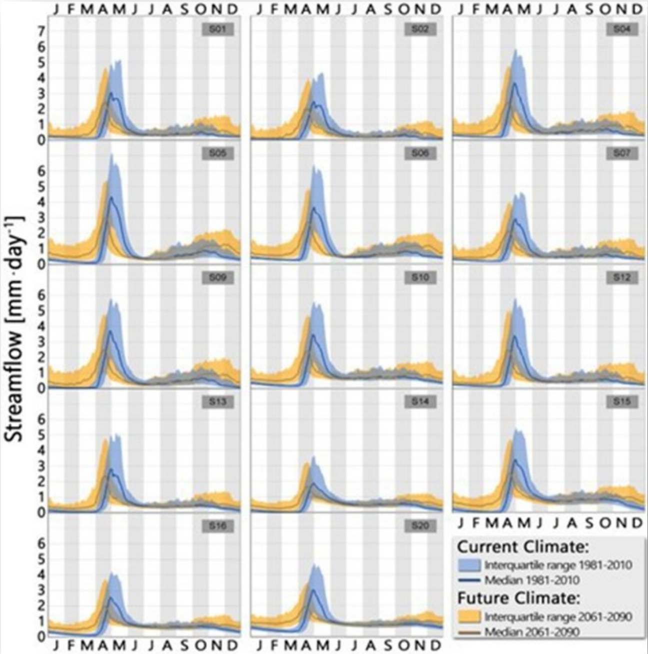


In C7 discharge has been measured since 1980 (above right), C2 and C4 from 1994 and the remaining stations from 2004. The are currently 11 regularly monitored water quality monitoring stations (above left). Six of the stations are in heated houses for year around measurements (above right).

Below: *Discharge in the different sub-catchments as determined by different catchment characteristics (Karlsen et al. 2016).*







***Above**: Simulated future streamflow in 14 sub-catchments. The reference period (blue) and future (orange) climate conditions are shown. The dark curve presents the median of all simulations (Teutschbein et al. 2016).*

Key references

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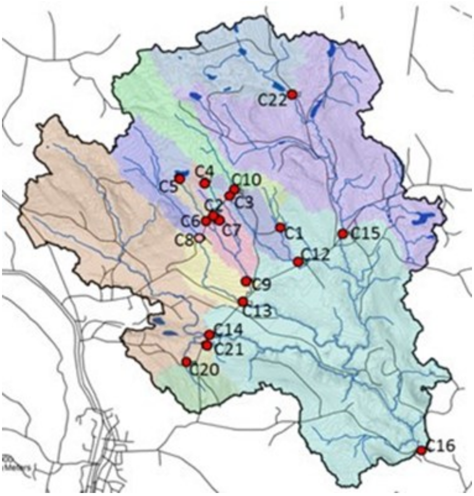
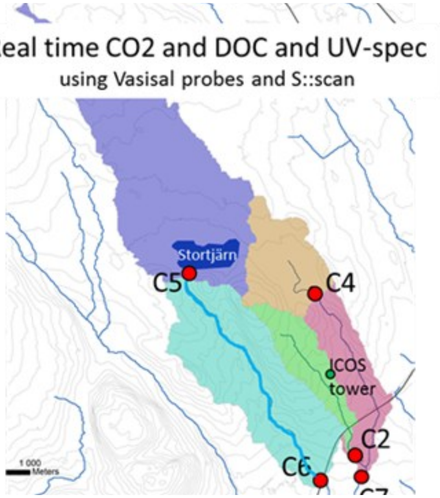
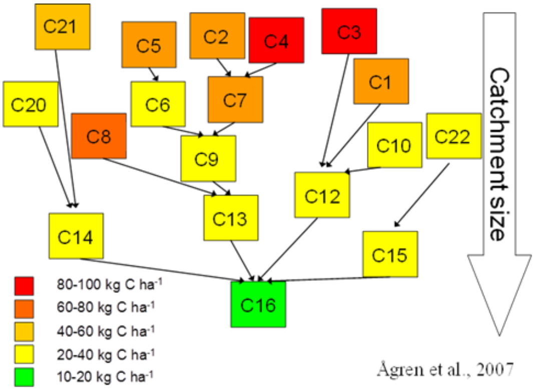
Krycklan and Stream Carbon

The stream carbon monitoring program in Krycklan began in 2002 with a grab sampling approach, collecting approximately 30 samples per year. These samples include dissolved organic carbon (DOC), carbon dioxide (CO2), methane (CH4), and UV absorbance spectra. In addition to grab sampling, a sensor network is being continuously expanded, with a primary focus on the central parts of the catchment to enable high-resolution, real-time monitoring of carbon dynamics.

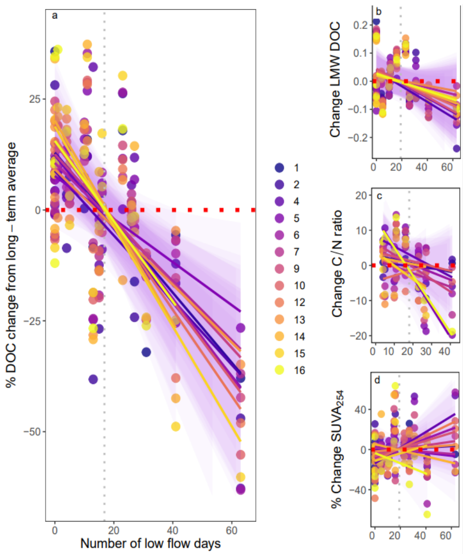




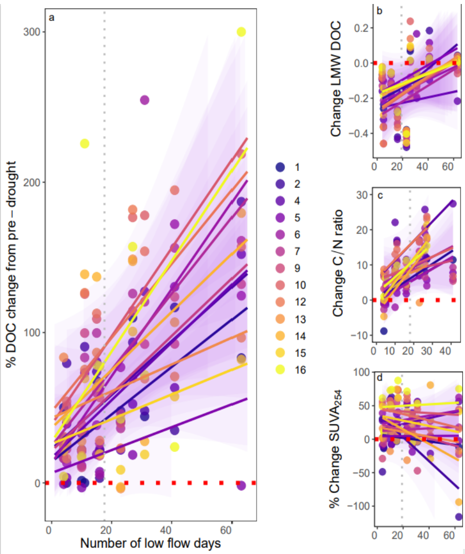


Above: *Annual export of DOC from the different sub-catchments in Krycklan. Note that the export of DIC can be as large, or even larger. Here you can also see how the streams are connected.*

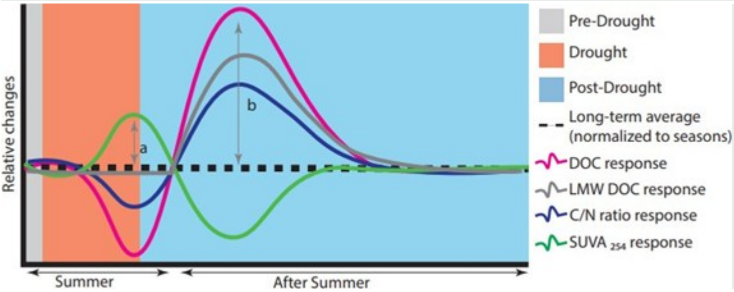
Drought Effects



Post-Drought Effects



__Above__: Stream chemical responses to summer drought severity across a boreal streams showing changes in (a) dissolved organic carbon (DOC), (b) low molecular weight DOC (LMW DOC), (c) carbon-to-nitrogen (C/N) ratio, and (d) specific ultraviolet absorbance at



***Left:** Conceptual responses of DOC, LMW DOC, C/N ratio, and SUVA254 to summer low flow conditions (Tiwari et al., 2022).*

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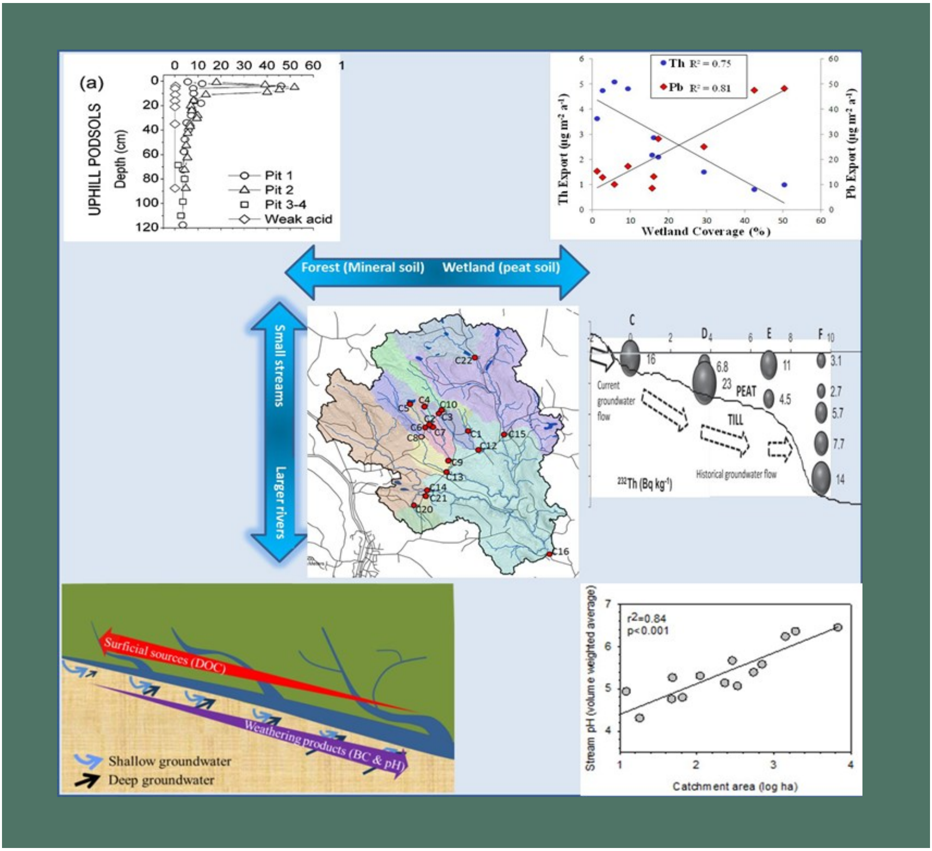
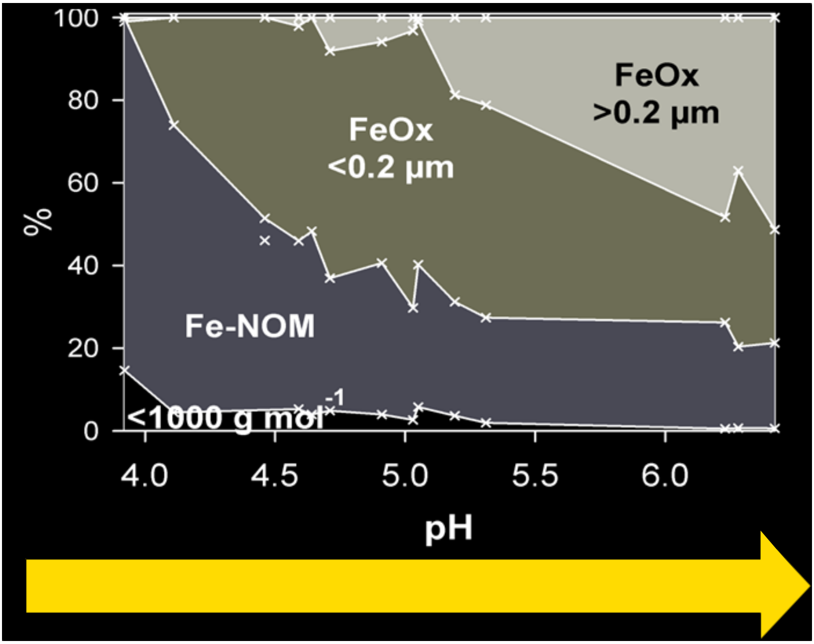
Krycklan and Biogeochemistry

The Krycklan Catchment Study focuses on the biogeochemical dynamics of boreal forest streams and soils, with long-term monitoring of carbon, nutrients, and metals. It combines high-frequency sensor data with grab sampling to understand how land use, climate, and hydrology influence water quality and elemental fluxes across forested landscapes.



The contrasting behavior of different elements in the landscape depends on
1) its affinity to organic matter and 2) the primary source of the element.
For the examples above, thorium (Th) and lead (Pb) affinity to organic matter are similar, but Th is a weathering product while Pb originates mainly from deposition.
Similarly, another relationship can be seen with pH which increases as the catchment size increase.



Above: Changes in iron speciation along a pH gradient, from acidic upstream streams to more neutral downstream conditions (adapted from Neubauer et al., 2013).

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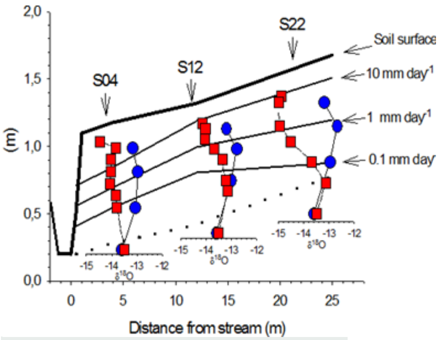
The Riparian Zone and the S-transect

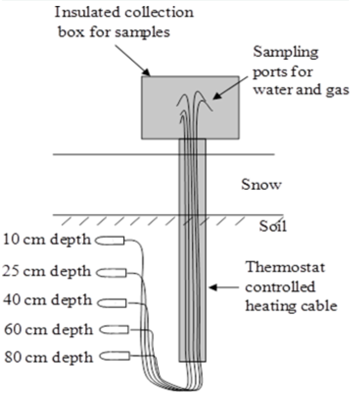
The riparian zone has a disproportional large impact on the stream biogeochemistry. Partly this is because it is the large last environment the soil water meets before becoming surface water. But this large influence also has to do with the fact that the riparian soil in the boreal region is highly organic rich, and therefore very different compared to most other soils in the catchment. The S-transect was installed 1997 and has been sampled monthly since.

The transect consists of ceramic suction lysimeters at 5-7 depths in three plots in the riparian zone 4 m from the stream (S04), 12 m from the stream (S12) and in the upslope mineral soil 22 m from the stream (S22). The installations are made so that samples can be collected all year by using a heating cable where the water passes through the frozen soil. The hydrology is focused in the upper horizons due to the hydrological conductivity which increases exponentially towards the soil surface.

The S-Transect

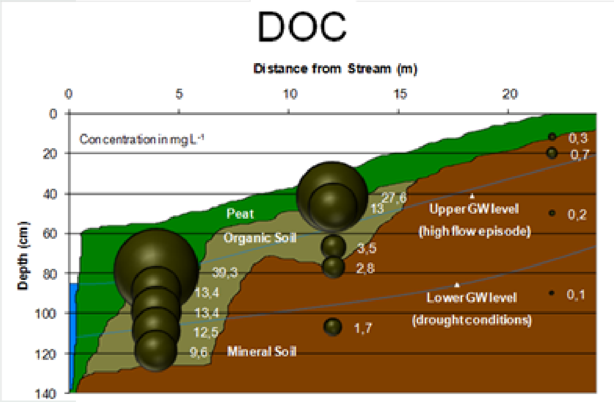


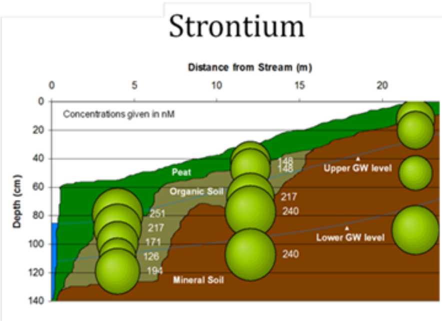
Ceramic suction lysimeters

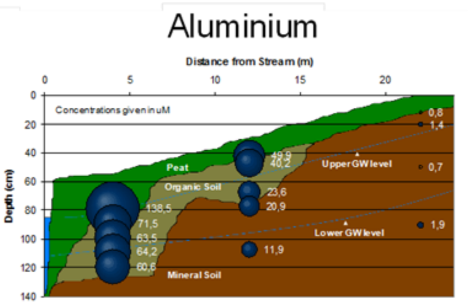


Riparian hydrological flow

Right: *Pattern of DOC in the S- transect. Note the very high concentration in the riparian zone and the much lower concentration uphill*







Above: *Contrasting patterns of strontium and aluminium highlight their differing affinities to dissolved organic carbon (DOC)—with strontium showing low affinity and aluminium exhibiting a strong one. The behavior of most other elements similarly depends on their interaction with DOC.*

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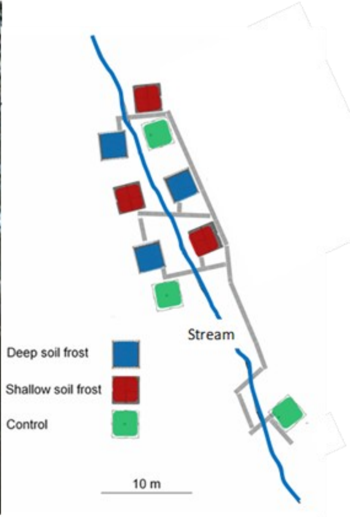
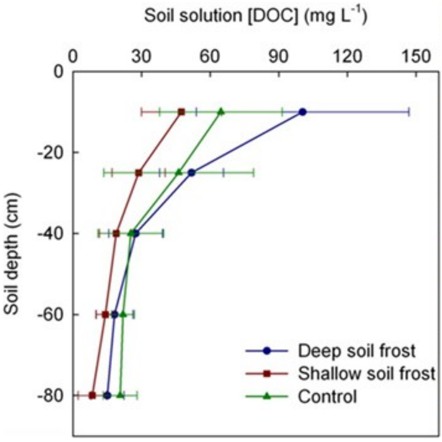
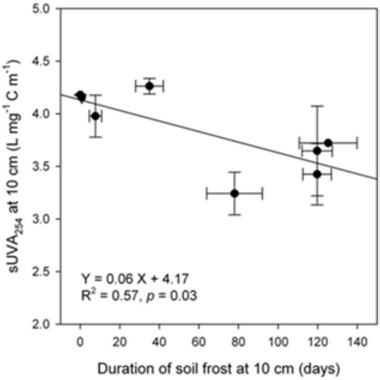
The Soil Frost Experiment



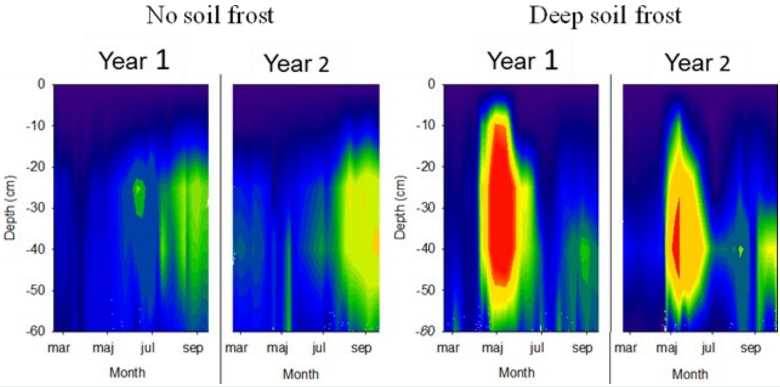
The soil frost experiment started in 2002 which makes it the longest ongoing experiment of its kind in the world. Winter conditions in the soil are strongly dependent on the timing and amount of snow. Little snow gives very cold soils, whereas early and large amounts of snow will result in "warm" soils.

Colder soils and deeper soil frost gives higher DOC concentrations in the upper soil layers. Colder soils also gives rise to higher DOC concentration in the streams during the spring flood. (From Haei et al. 2010).





Left: *The DOC quality is affected negatively by the length of winter. Here it is measured as SUVA. (From Haei et al. 2011).*



Below: *CO2 concentrations at different depths in the soil over two years without soil frost (left) and with extensive soil frost (right). (From Öquist and Laudon, 2008).*

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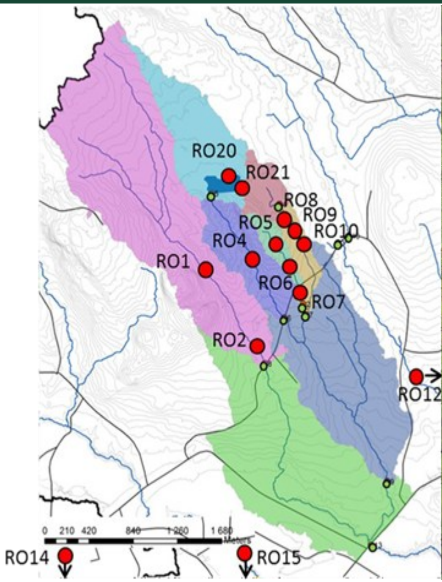
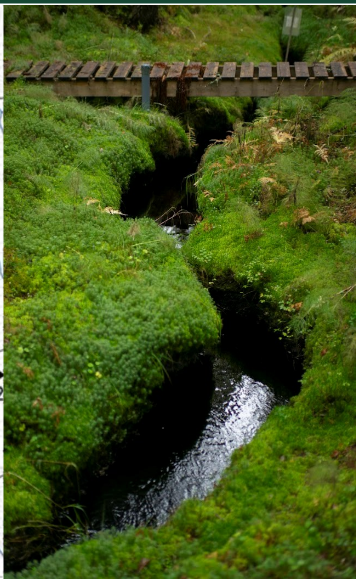
The Riparian Observatory

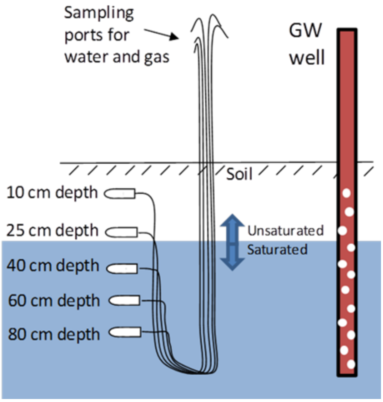




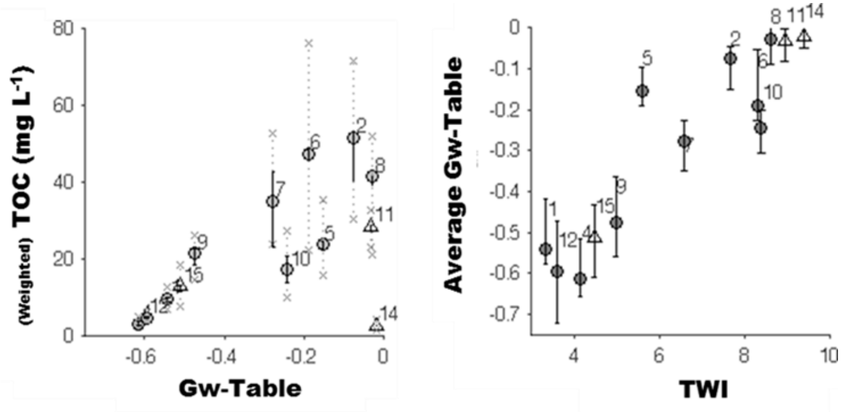
The Riparian Observatory (RO) consists of 20 strategically distributed sites across the Krycklan catchment, designed to study soil–surface water interactions from both hydrological and biogeochemical perspectives. Seven of these sites follow a similar design to the S-transect, incorporating instrumented hillslope-to-riparian transects to capture lateral flow and chemical gradients.

Each RO site is equipped with instruments for monitoring soil water, soil gas (including CO2 and CH4), and groundwater (GW) at multiple depths. This setup allows detailed tracking of water movement, solute transport, and redox-sensitive biogeochemical processes.

At the seven transect-style sites, additional installations are placed 20–30 meters upslope from the main riparian zone plots. These allow researchers to study the chemical evolution of water and gas as it moves from the upland through the soil profile into the riparian interface and ultimately into surface waters.



The RO network contributes to understanding how riparian zones regulate stream chemistry, especially in response to changing climate, hydrology, and land use.



The mean-weighted TOC concentration shows a strong correlation with the average groundwater table at each location (left), with the exception of RO14, which lies on sediment-rich soils. In turn, the average groundwater table (right) is strongly correlated with the Topographic Wetness Index (TWI).

Since TWI can be derived from digital elevation models, it offers a practical tool for predicting TOC concentrations in riparian soils. (Adapted from Grabs et al., 2012).

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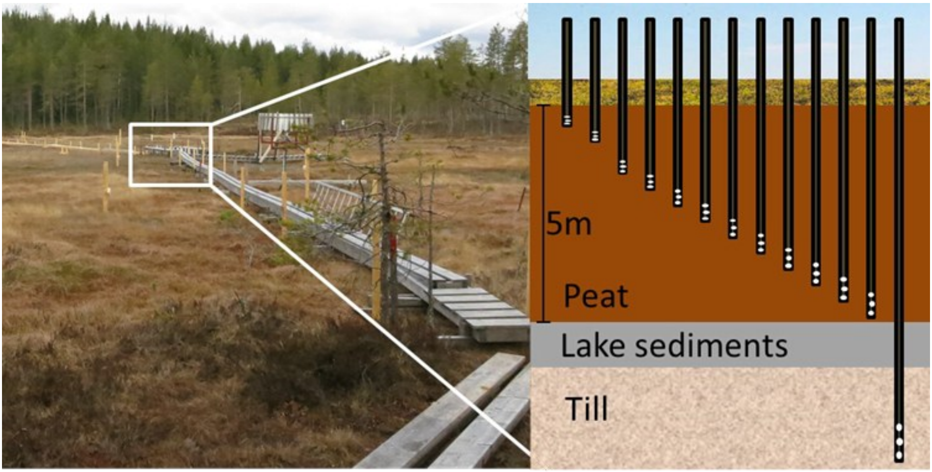
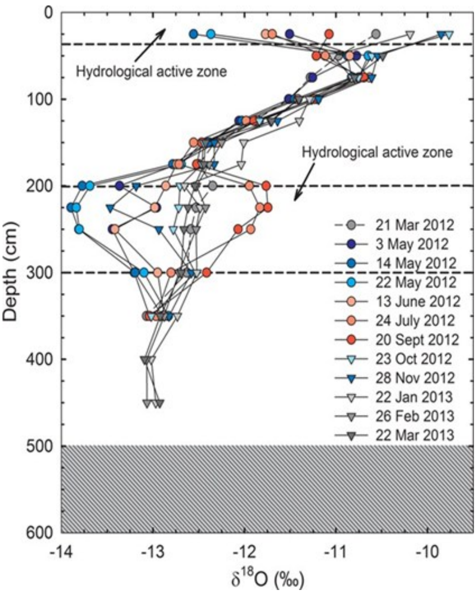
The Kallkäls Mire

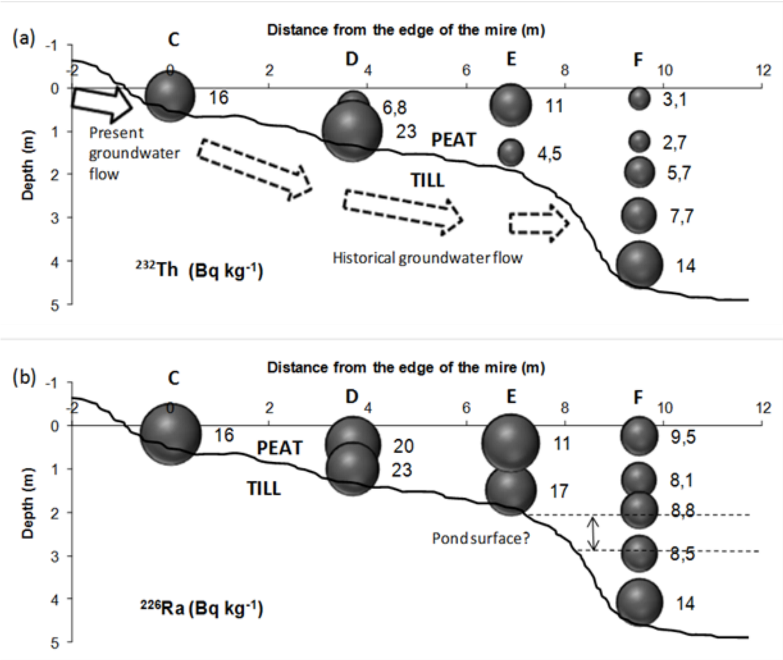


Kallkäls mire serves as the headwater source for stream **C4** and is home to the well-known **"Russian wells"**—a series of nested piezometers installed at multiple depths within and beneath the mire. These installations enable detailed sampling of groundwater and pore water, allowing researchers to study vertical hydrological and biogeochemical gradients in the peat profile.



***Left**: Seasonal flow pathways through the mire traced using stable oxygen-18 ($\delta^{18}O$) isotopes during spring, summer, and autumn. Two main flow routes dominate: surface overland flow spreading across the mire, and deeper subsurface flow traveling through preferential pathways at depths of 200–300 cm within the peat.*

These pathways highlight the complex hydrological connectivity influencing water and solute transport in the mire environment. (From Peralta-Tapia et al., 2015).



Profile of chemical analyses tracing water flow from mineral soil into the mire. Shown here are the concentrations of thorium (Th) (a), an element with a strong affinity for dissolved organic carbon (DOC), and radium (Ra) (b), which exhibits low affinity for DOC. These profiles illustrate how element behavior varies along the flow path. *(From Lidman et al., 2012).*

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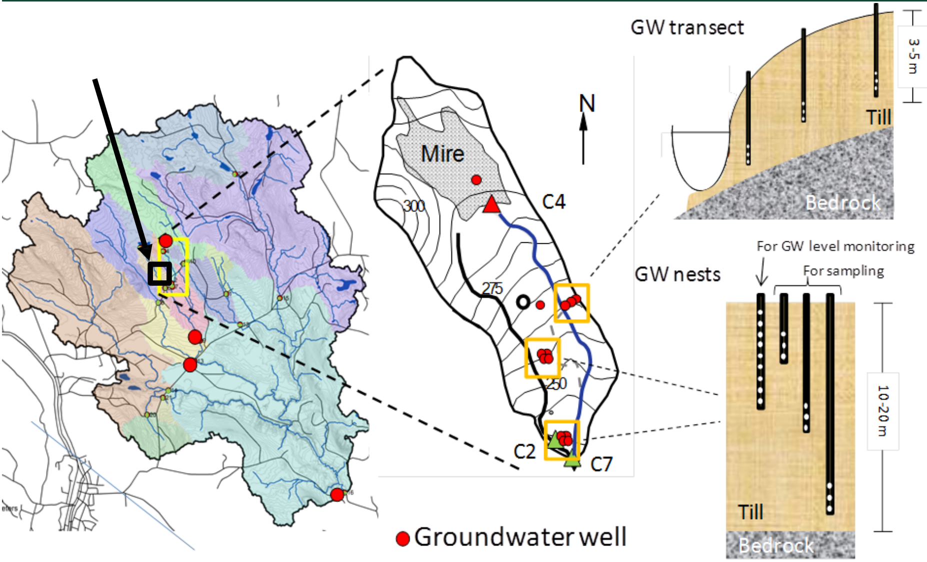
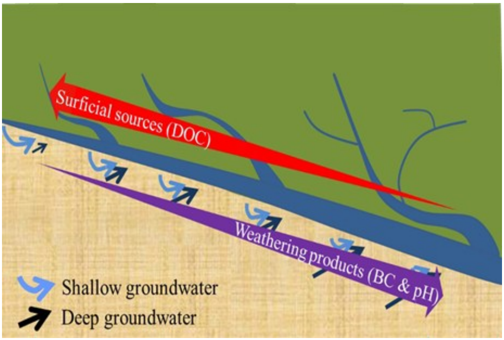
Groundwater Observatory (GO)

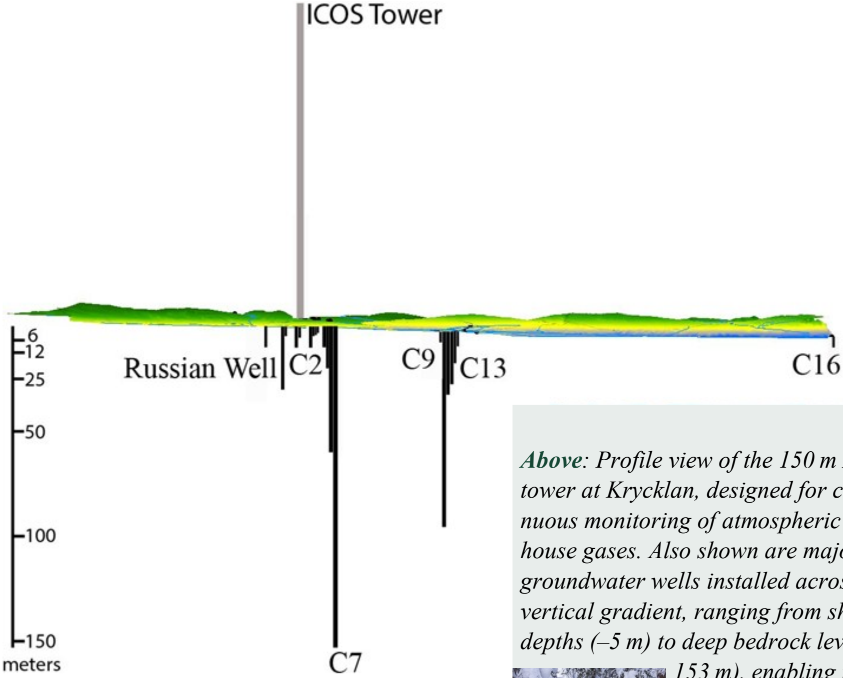


Above: Groundwater wells in Krycklan, highlighting the area encompassing 50 newly install-led wells as part of the observatory network.

A total of nearly 20 groundwater wells have been installed across the Krycklan Catchment, ranging in depth from 5 meters to over 150 meters. These installations were strategically placed to provide comprehensive coverage of the catchment, enabling both regional-scale investigations of groundwater systems and more localized studies of water flow pathways. The earliest wells were installed by the Swedish Geological Survey (SGU) in the 1980s and have been monitored continuously since then. The majority of the remaining wells were added in 2012 to expand monitoring capacity and research scope.



Below: Schematic figure of water flow pathway in Krycklan (Peralta- Tapia et al. 2015) showing the long travel distance for water sur- facing downstream in the larger rivers.



__Above__: Profile view of the 150 m ICOS tower at Krycklan, designed for continuous monitoring of atmospheric greenhouse gases. Also shown are major groundwater wells installed across a vertical gradient, ranging from shallow depths (–5 m) to deep bedrock levels (–153 m), enabling integrated observation of subsurface hydrology, biogeochemistry, and land-atmosphere interactions.

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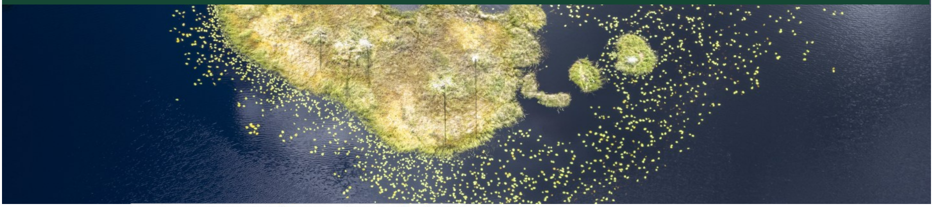
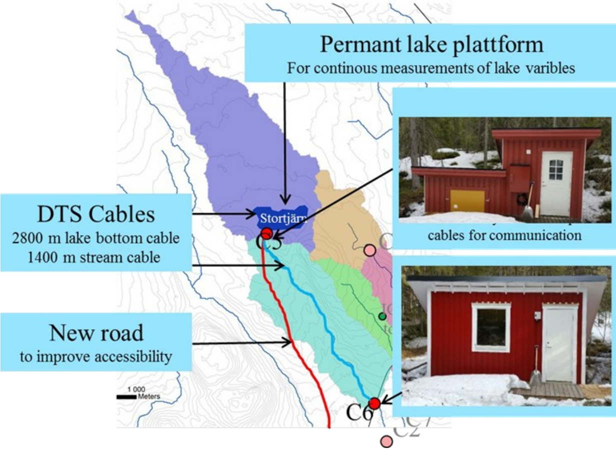
Lake studies and infrastructure at Stortjärnen





Lake Stortjärn is one of the most active research hubs within the Krycklan catchment, both in terms of new scientific projects and infrastructure development.

Despite its small size, the lake serves as the headwater for sub-catchment C6, with water flowing into the stream monitored at gauging station C5.

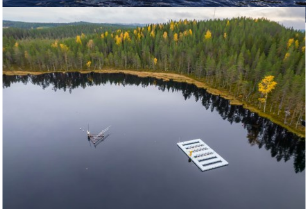
This site enables high-resolution, year-round monitoring of hydrology and water chemistry. Discharge is measured continuously using a heated weir house, and key parameters including streamflow, dissolved organic carbon (DOC), major ions, and isotopic tracers are systematically recorded.

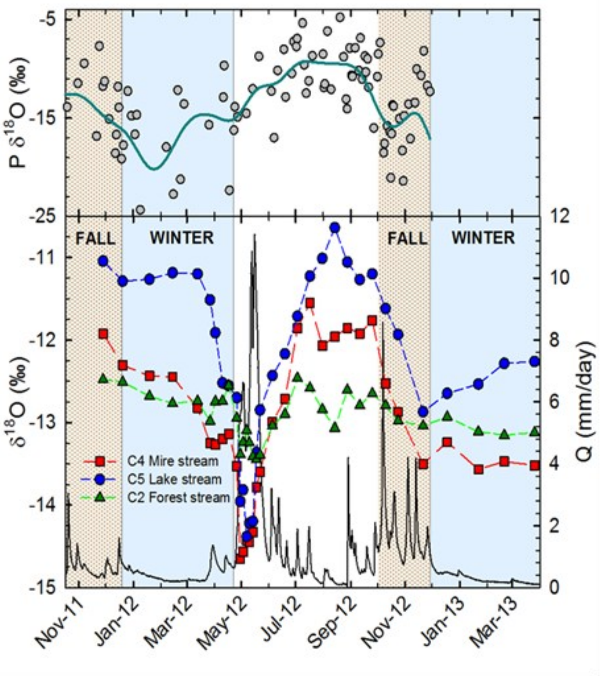
All data from the site are openly available through the SITES data portal, supporting long-term research and collaboration.

AquaNet Experiment – Lake Stortjärn

At Lake Stortjärn, the AquaNet experiment uses floating mesocosms to study how freshwater ecosystems respond to stressors like nutrient enrichment and warming.

As part of a global network, it allows researchers to compare biodiversity and ecosystem responses across regions, contributing to our understanding of boreal lake resilience under environmental change.





Above: *The contrasting behavior between the lake outlet (blue C5), mire outlet (green C4) and forested stream (red C2) under a full year. Note the much larger response to snow melt and rain episodes in the lake (blue) compared to both the mire, (red) but especially the forested stream (green) (from Peralta-Tapia et al. 2015).*

Key references

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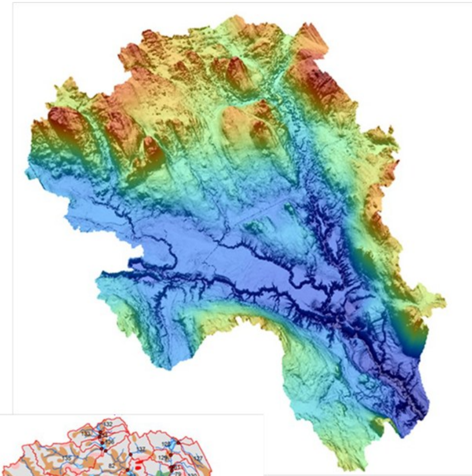
Topography, Soils and Vegetation

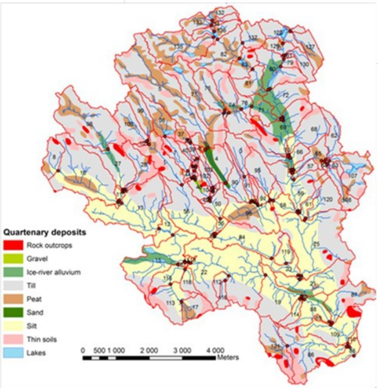
The Krycklan catchment spans 6,780 hectares and features gently rolling terrain shaped by past glaciation. High-resolution LiDAR-based Digital Elevation Models (DEMs) at 10, 5, and 0.5m resolution are available for the entire area, providing detailed topographic data essential for hydrological modeling and landscape analysis.

Glacial till soils dominate the upland areas, while peat soils are common in wetlands and riparian zones, influencing water movement and biogeochemical processes. Vegetation is characteristic of the boreal biome, with uplands covered by Norway spruce and Scots pine, and wetter areas supporting birch, shrubs, Sphagnum mosses, and other moisture-loving species.

The catchment includes both regular monitoring sites and survey catchments, the latter being sampled less frequently but offering broader spatial coverage. Together, these features support integrated research on hydrology, carbon cycling, and ecosystem responses to environmental change.

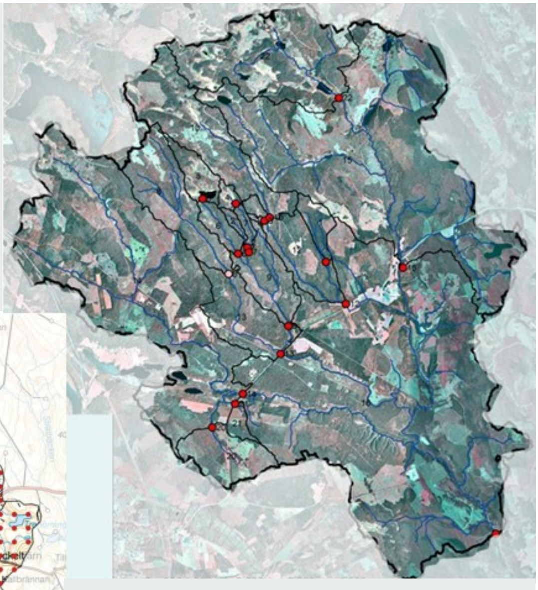


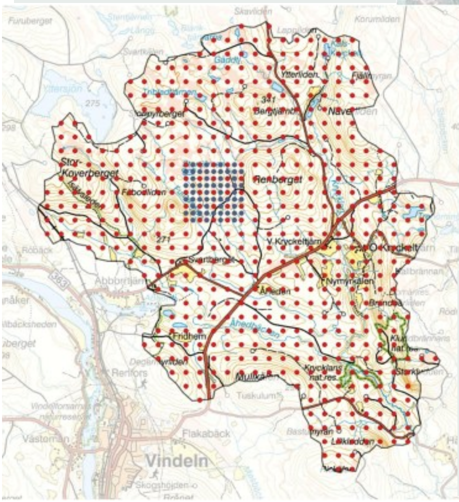
Lidar Based Topography
High-resolution LiDAR data provides detailed Digital Elevation Models (DEMs) at 10m, 5m, and 0.5m resolution across Krycklan. These models are key for mapping terrain, modeling water flow, and understanding landscape–hydrology interactions.



Quaternary Deposits Map
Map showing Quaternary deposits across the catchment with 100 survey locations superimposed for detailed geological sampling.

IR Orthophoto
Infrared orthophoto of the Krycklan catchment displaying vegetation and landscape features, with regular monitoring sites marked in red.





Vegetation Survey
Survey locations (black circles) mapped using the National Forest Inventory protocol, with higher sampling density around the ICOS tower at the catchment center.

Soil Survey:
The soil survey involved detailed mapping and characterization of soil types, horizons, and properties across the landscape. It identified dominant soil classes such as podzols and peat soils, documenting variations in organic layer thickness, texture, pH, and nutrient content.

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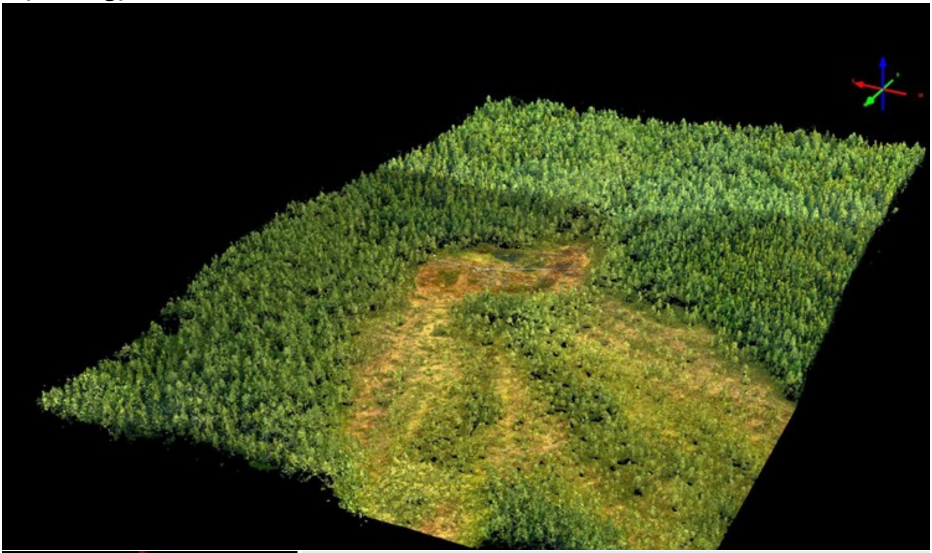
Remote Sensing in Krycklan

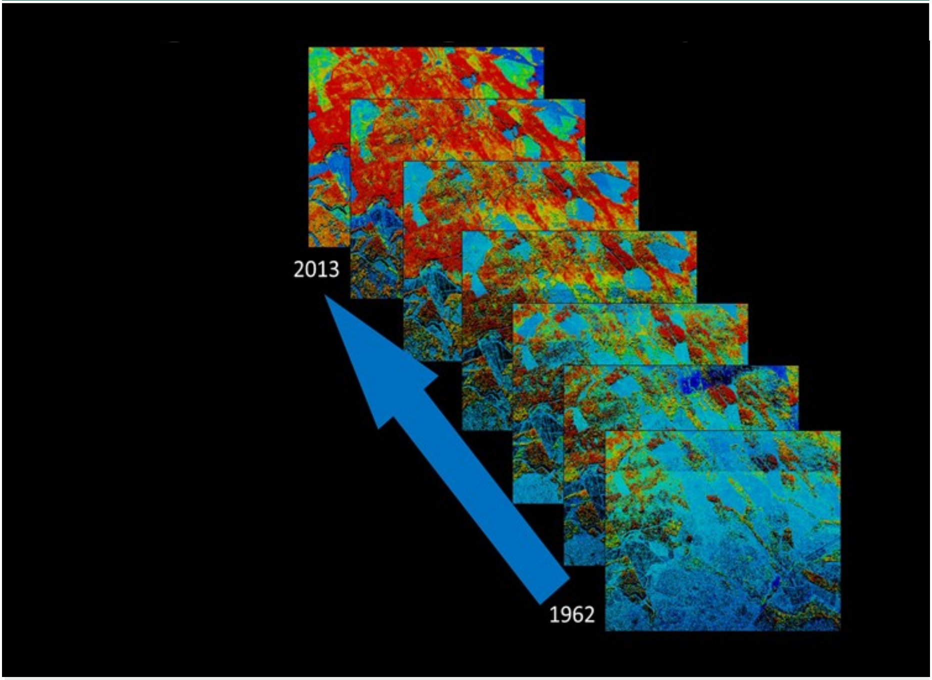
Remote sensing is a rapidly advancing research area in the Krycklan catchment, providing detailed insights into vegetation, landscape changes, and hydrology.



Above: A 3D point cloud created using stereo photogrammetry from ultra-high-resolution aerial imagery. This detailed model captures the topography and vegetation structure of sites such as the Kallkälsmyren, enabling precise analysis of terrain and landscape features.

Left: Example of data collected using terrestrial laser scanning using the Trimble TX8 scanner. The picture is a side- view of the three dimensional point measurements of a pine tree at the ICOS tower (note the supporting wires in the picture). Each point is color coded by the height above ground level.

Vegetation height development



Right: Aerial images of the Krycklan catchment from 1962 to 2013, showing changes in vegetation height and structure over five decades.

Key references

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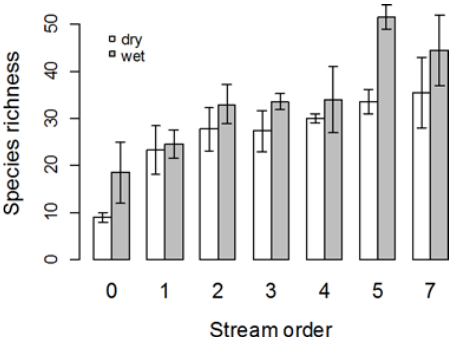
Ågren. A. et al., (2014). Evaluating digital terrain indices for soil wetness mapping - a Swedish case study. Hydrology and Earth System Sciences, 18(9), 3623–3634. https://doi.org/10.5194/hess-18-3623-2014

Krycklan Stream and Plant Ecology

A number of stream and riparian ecology studies have been conducted related to plants, fish and invertebrates in aquatic, terrestrial riparian ecosystems. These results are now a basis for the new SEPA liming guidelines.



***Above**: Riparian Zone plant species diversity in dry and wet locations along streams ranging from hollows (zero order streams) in Krycklan to the Vindeln River (7 order stream) (Kuglerová et al. 2014).*

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Burrows, R., et al., (2015). Nitrogen limitation of heterotrophic biofilms in boreal streams. Freshwater Biology, 60(7), 1237–1251. https://doi.org/10.1111/fwb.12549

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Hydrology and Biogeochemistry Lab

Krycklan is supported by a state of the art Lab that is equipped with standard instruments for analyzing approximately 2500 samples per year in soil and water chemistry following standard operating procedures.

Some of the facilities and equipment available includes:

Continous flow Autoanalyzers – Measure ammonium, nitrate/nitrite, phosphate in surface water and soil extracts , and total Kjeldal N & P in soils, sediments, and plants.

Ion Chromatography (IC) – Analyze major anions in water.

Gas Chromatography (GC) – Detect and separate gases like CO_2, CH_4, N_2O, and volatile compounds.

pH & Conductivity Meters – Rapid automatic analysis of zero headspace pH and conductivity in water.

Total Carbon & Nitrogen Analyzers – Measure total C and N in soils, plants, and water.

Phospholipid Fatty Acid (PLFA) Analysis – Profile soil microbial communities.

Sample Preparation Facilities – Grinding, weighing, filtration, freeze-drying, cryogenic extraction, Kjeldal digestion.

Continuous Flow Isotope Ratio Mass Spectrometers (CF-IRMS) – Measure $\delta^{13}C$, $\delta^{15}N$, $\delta^{18}O$, $\delta^{2}H$ in solids, liquids, and gases.

Gas Bench (GB-IRMS) – Analyze dissolved or produced gases (CO_2, CH_4).

GC-C-IRMS & GC-IRMS – Compound-specific isotope analysis of organic and volatile compounds.

Temperature Conversion Elemental Analyzer – IRMS (TCEA-IRMS) – Convert solids to gases for isotope measurement.

Cavity Ring-Down Laser Spectrometry – High-precision isotope measurements in water and gases.

More information : www.slu.se/FEMLAB

DATABASE

An active database that updates current analysis onto the Svartberget and SITES dataportal for easy data sharing possibilities and long-term storage possibilities.

Data includes:

- Stream Chemistry
- Meteorology Data
- Flux measurements
- Hydrological runoff measurements
- Groundwater chemistry
- Precipitation Chemistry

READ MORE HERE

Krycklan—A breif history

Research in Krycklan started over 100 years ago with the study of paludification effects on forest growth. In the 1970's, the Svartberget field station was established. Research then was focused more on forest hydrology and biogeochemical cycling. During the 1990's, a decade of more intensive work on the role of acid deposition on stream water chemistry contributed to new views of anthropogenic acidification and natural acidity in organic carbon-rich boreal waters. In recent years, the research scope expanded substantially to include more work on biogeochemistry, carbon cycling, hydrology and ecology. More intensive research also began on the connections between soils and surface waters, leading to a process-based understanding of the regulation of stream water chemistry.

Recognition of the need to work at the landscape scale when addressing climatic influences on aquatic ecology led to the expansion of the Svartberget catchment from 50 ha to the 6800 ha Krycklan catchment in 2002. This has further increased the research scope to include both fundamental research questions as well as management issues that are currently addressed.

In recent years, Krycklan has transformed into a unique experimental platform for testing pure and applied research questions in a natural environment. The platform continuously attracts new scientific projects as well as directly collaborates with the Swedish Nuclear Waste Program, Swedish EPA, Sveaskog and others.

Krycklan would not be possible without the excellent support from the field and laboratory crew.

Read more and access data at www.slu.se/Krycklan.

Photos and illustrations by Peder Blomkvist, Ishi Buffam, Tejshree Tiwari, Tobias Lindborg, Eliza M. Hasselquist, Nataliia Kozii, Viktor Sjöblom, Johannes Tiwari, Ola Olofsson and Andreas Palmen.

Layout by Tejshree Tiwari.

DO YOU WANT TO KNOW MORE?

The Krycklan Catchment Study is primarily funded by: