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FÖRSLAG PÅ EXAMENSARBETEN FÖR GEOVETARE PÅ KANDIDATNIVÅ

Hydrologi

1. Flow fields and the water balance for the Bergianska Trädgåden wetland

Wetlands are often constructed to provide a “natural” method to treat fresh water by removing excess nutrients and improving overall water quality. Recently, Stockholm University has constructed a wetland that receives water draining from Bergianska Trädgården. In this project you will look at and explore the hydrology of this wetland. Some main questions to answer are how does water move into and through this wetland and how does this movement of water vary through the year. The ability of water to move into and through this system directly influences the ability of this wetland to provide water treatment.

Advisors: Steve Lyon and Fernando Jaramillo

2. Changes in the spatial distribution and frequency of arctic lakes

Warming of northern, high-latitude environments can lead to thawing of ground ice and alterations of the cryosphere. This can have great influence on the presence and distribution of lakes in arctic regions. This project will look at the change in spatial coverage of lakes for a region of northern Eurasia. Main questions to answer are if lakes are appearing or disappearing in the region and if such changes are more frequent or less frequent depending on the size of lakes considered. These lakes make influence the storage available in these landscapes and therefore play an important role in the water balance of these regions.

Advisors: Steve Lyon and Johanna Mård-Karlsson

3. High-level nuclear waste repositories

Investigations related to geological storage of spent nuclear fuel are important ongoing issues for many countries worldwide. A prime candidate geological environment for constructing subsurface repositories is crystalline bedrock. Crystalline rock has several advantages, including the ability to isolate material under long periods of time without the need of monitoring. Despite extremely low hydraulic conductivities typical for crystalline rock, flow occurs primarily through fractures. Therefore, understanding fractured rock, and how water and contaminants are transported in bedrock is of significant importance, both for short-term repository construction and long-term repository performance.

In this project it is proposed that the student will investigate fracture flow and transport phenomena, using data available from current field characterisation programs in Sweden and Finland. In particular, a fracture growth model applicable to crystalline fractured rock needs to be developed. Also, methods to evaluate simulated models against in-situ borehole flow measurements are needed. If time permits, modelling of contaminant transport may also be conducted. The overall aim is to gain an improved understanding of subsurface flow and transport processes occurring in fractured bedrock.

Advisor: Andrew Frampton

4. Hydrothermal vents

Deep sea hydrothermal vents are geothermally heated water and mineral sediment mixtures emitted from fissures protruding the seabed, known as black or white smokers. These typically form along locations where two tectonic plates are diverging and new crust is being formed, such as along the Mid-ocean ridges. In contrast to the approximately 2 °C ambient sea water temperature at these depths, water emerges from vents at temperatures up to 500 °C, which at sufficient depths (below approximately 3000 m) causes the emitting water to be a supercritical fluid. Furthermore, relative to the majority of the deep sea, the areas around submarine hydrothermal vents are biologically more productive, often hosting complex communities sustained by heat and dissolved chemicals in the vent fluids.

The overall aim of this project is to gain an improved understanding of the phenomena of hydrothermal vents. In particular, it is proposed that suitable hydrogeological models of hydrothermal vents be constructed, based on available data. This will involve general investigations on available knowledge of the phenomena of hydrothermal vents, including acquiring and analysing data from the IODP programme and other relevant sources.

Advisor: Andrew Frampton

5. Permafrost

Vast amounts of global freshwater resources are stored as ice in glaciers and beneath the ground in permafrost regions. The extent of permafrost regions changes in a changing climate, and degrading permafrost may also release storage of nutrients frozen in ice, impacting carbon cycling and potentially further impacting climate

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change. It is therefore necessary to improve our understanding of permafrost phenomena, degradation processes, and how this may impact subsurface flow and transport pathways, as well as carbon cycling.

Advisor: Andrew Frampton

The aim of this project includes gaining an understanding of relevant permafrost processes as well as how flow and transport phenomena are influenced by permafrost dynamics. General investigations into permafrost-affected landscapes will be conducted, including acquiring and analysing existing field data, for the purpose of incorporating field measurements to conceptual and applied models. An essential aspect here is to adopt suitable permafrost catchment-scale models, based on available field data.

6. Grundvattenföroreningar i deponiområden

(Samarbete med Bygg- och miljönämnden i Gävle.)

Här finns potential att medverka i pågående projekt vid kommunens Bygg- och miljönämnden och i samarbete med deras konsulter för att studera grundvattenföroreningar i miljömässigt känsliga områden. Flera aspekter kan analyseras, förslagsvis mha lämpliga grundvattenmodeller baserat på aktuell data och kunskap om området. Tillgång till kartmaterial och databaser genom en bra GIS – struktur och genom ett kommunalt Geodata-samverkansavtal.

6a. Avans gamla deponi. Ett område strax utanför Gävle där en fd kommunsotipp och snötipp ligger och som numera är golfbana. Dock finns det anledning att tro att det rinner ut diverse miljöfarliga föroreningar till havsviken, Avasältorna. Sältorna är ett Natura 2000 område och därför är det extra viktigt att kunna bedöma och åtgärda utläckage. Detta är ett pågående ärende där Tekniska kontoret i Gävle ska ge förslag på vad som behöver göras för att minska utläckaget.

6b. Näringens industriområde (stadsområde). Detta är utfylld industrimark med flera gamla deponier. Eftersom grundvattenytan i området ligger nära markytan påverkas denna av havsnivån, med bl.a. risk för saltvattenintrång samt ökad risk för utsläpp av föroreningar till havet. Vidare antas transportvägar ske via Avasältorna som är ett Natura 2000-område. En aspekt är att utvärdera om dagvatten kan avledas från deponiområdet till en avsnörd kanal (Holmkanalen).

6c. Gavleån. Generella frågeställningar ur flera perspektiv, bla badvattenkvalitet, miljöpåverkan och översvämningsrisker. Förslagsvis analyser i relation med klimatpåverkan.

Landskapsekologi

7. Who, how, when and where? Comparing historic and present-day plant inventory data to assess the movement of plant species in Sweden.

Local and regional plant floras have been described and mapped by enthusiastic botanists for more than 200 years. By comparing plant atlases from different times, information about extinctions, invasions and range changes can be found. This can later be linked to the dispersal and life history traits of the plant species, shedding light on the long distance dispersal abilities of plant species in a changing environment.

Supervisors: [Alistair Auffret](#) and [Sara Cousins](#)

8. The effect of site characteristics, management history and surrounding landscape on the plant species diversity of volunteer managed hay meadows.

Many of the Swedish Society for Nature Conservation's (Naturskyddsföreningen) local groups tend a hay-meadow, which they manage by clearing in the spring, and cutting and removing the grass in the late summer. By using existing species lists and making new inventories of other meadows, examining old and present day maps, and interviewing the volunteers, the influence of land use history, management and surrounding habitats on the success of such conservation work can be determined.

Supervisors: [Alistair Auffret](#) and [Sara Cousins](#)

9. Motorway verges as dispersal corridors: the role of road age and nearby source habitats.

Road verges are known to act as remnant habitats for grassland plant species, and motor vehicles are effective seed dispersers. Wide motorway verges, which form long, continuous strips of regularly mown grass should therefore be able to provide a useful the regional connectivity essential for future range changes. Comparing the flora of new and older motorway verges, and those with much or little semi-natural grassland in the surrounding area, one will be able to assess the colonisation of these verges, and from that their potential for

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providing useful dispersal corridors for grassland plants.

Supervisors: [Alistair Auffret](#) and [Sara Cousins](#)

10. Land use changes in Sweden - a hundred year study

Two main land use trends occur in Sweden and Europe, intensification of agriculture and abandonment. How important is the physical geography, farm isolation, local-regional-global driving forces and climate for these trends? This will be investigated at a parish level by using the KLSA database for data collection. This can be divided in two parts a) land use change and effect on biodiversity (Sara), and b) land use change and effect of ecosystem services (Regina)

Supervisors: [Sara Cousins](#) and [Regina Lindborg](#)

11. Are wild animals efficient vectors of seed dispersal in a fragmented landscape?

Seed dispersal is a key process for the survival of plant communities in fragmented landscapes. Yet, how fragmented habitat patches are connected and whether seeds are effectively being dispersed by animals between these patches remains largely an open question. Through GPS-mapping of animal paths, track and animal counts, the main aim of this project will be to identify how and whether grassland fragments are connected by movement of wild animals. Adding vegetation data, highly visited fragmented habitat patches should yield a more homogenized herbaceous vegetation, assuming that the animals not only connect the fragmented habitat patches but also actively disperse seeds in the fragmented landscapes.

Supervisors: [Jan Plue](#) and [Alistair Auffret](#)

12. How many seeds are moved around? Mimicing dispersal by wild animals.

Wild animals are vectors which supposedly allow seeds to disperse in a landscape. Nonetheless, the rate at which seeds are collected within their fur or deposited in the landscape while animals move around are quite poorly understood. Many studies assume these seed accumulation or seed loss rates to be constant which at first glance seems very counter-intuitive. To estimate this, we intend to rub animal furs of either stuffed animals or live animals (e.g. a dog or a donkey) with seeds marked with fluorescent paint, walk around with these (imitation) animals in different landscapes and retrieve the marked seeds using a UV-lamp. This will estimate seed losses from animals furs, enlightening how efficient animals are as dispersal vectors for seeds.

Supervisors: [Jan Plue](#) and [Alistair Auffret](#)

13. Which wetlands are we actually missing? (Bachelor project)

Wetlands are unique features of the landscape that support a variety of organisms and are also home to many endemic species. These systems are threatened by global change and species therefore might rely on small wetlands as cornerstones to allow for dispersal. The Swedish Wetland Inventory (VMI) assessed wetland quantity and quality under the last 20 years with the focus on medium and large wetlands by using field inventories and aerial photographs. The purpose of the study is to assess location, number, size and type of small wetlands (< 1ha) by obtaining fine scale maps from nongovernmental organizations (orienteringskartor, aerial photographs, etc.). The project is part of the EkoKlim project.

Supervisors: [Matti Ermold](#) and [Sara Cousins](#)

14. Historic changes of wetland distribution in Sweden (Bachelor project)

Wetlands are among the most diverse ecosystems on the planet. They are not only diverse in the number of species they support but also in the number of different types of wetland that exist. Under the last two centuries around 50 percent of wetlands have been lost through drainage or removal of peat. In order to gauge the current extent of species loss and to start conservation efforts, it is important to know which wetland types have been lost. The purpose of this study is to assess changes in wetland type and area by comparing wetland distribution in Sörmland County between old maps from the 19th century (Häradskarta) to today. The project is part of the EkoKlim project, and can be extended to a master project by including field inventories.

Supervisors: [Sara Cousins](#) and [Matti Ermold](#)

15. Recreation in rural landscapes - what do people appreciate?

One important topic currently on the sustainable agenda is how to create a more multifunctional agricultural landscape. One framework that is often used is the ecosystem service approach. The most important ecosystem service in the agricultural landscape is of course production of food and fiber. However, sustain outdoor recreation in these landscapes is also a clear political goal in Sweden and other parts of northern Europe. In this Master project the aim is to study how different farmland interventions are perceived by

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different stakeholder groups. The study will be performed in Skåne in already selected farms. Relevant focus groups will be selected, e.g. STF, Bird watchers, SNF, local entrepreneurs etc, for discussion and interview. Specific protocols and photos will also be used. This master project is a part of a large Swedish research program (SAPES), including Stockholm University, Lund University and SLU Uppsala, and the student will also be collaborating with some of the other researcher within this project.

Supervisors: [Regina Lindborg](#) and [Thomas Hahn](#) (Stockholm Resilience Centre)

16. Evaluating the Common Agricultural Policy: Integrating the voices of different actors to identify gaps and needs for change

The European Common Agricultural Policy (CAP) absorbs currently about 40% of the European Union budget. The directives and different types of subsidies coming from CAP are uniformly applied to all member states, despite of their diversity both in physical and socio-economical contexts. Despite the many analyses written about CAP, studies that combine the perspectives of farmers, scientists and regional/national governmental institutions on the performance of this policy are lacking in the literature. The objective of this project is to make a critical analysis of CAP, by integrating the perspectives of different actors across scales. The main tasks will include performing interviews with farmers, scientists, regional and national government institutions. By integrating the voices of these different actors, it will be possible to identify the main gaps and needs for change, positive and negative sides of the current policy and opportunities for transformation. Possible travel to Portugal to perform interviews with help of a local student (to be confirmed).

Supervisors: [Regina Lindborg](#) and [Cibele Queiroz](#) (Stockholm Resilience Centre)

Glacial geomorphology

17. Tors and Boulders at the Slopes of the Preselis Hills, Southern Wales

Except for its beauty have the Preselis area earned fame and glory from being the source area of the Stonehenge bluestones. Theories try to explain the existence of the bluestones at the Salisbury Plain by either transportation by prehistoric settlers or by glacier ice. The glacial theory is hampered by the uncertainty of the extent of glaciations at the Preselis area. This project will try to understand the distribution of boulders at Preselis Hills by using satellite imagery, GIS and field studies.

Handledare: Krister Jansson

18. Image analysis techniques for measurements of ice flow direction on striated bedrock surfaces, inferences on glacial processes

Measurements of ice flow direction on a striated bedrock surface are normally accomplished using a compass. We here want to investigate whether field studies of striae can be accompanied by additional measurements (and verification) on photographs or scans of the striated bedrock surfaces in a laboratory or computerized setting. To that end, a bedrock surface from Arctic Canada has been scanned to produce a detailed Digital Elevation Model, which will be analysed in a GIS and by different image analysis techniques (Fast Fourier Transformation and stereoscopically techniques). The goal with the project is to develop this method and to analysis landform-shaping processes regarding small-scale glacial erosional features.

Handledare: Krister Jansson

19. The deglacial pattern and glacial lakes of the Torneträsk area, Sweden

The Torneträsk area holds an exciting and poorly understood landform record. The formerly coverage by cold-based ice and the preservation of "old" landforms complicate the interpretation of the landform record. This project aim to reconstruct the deglacial ice margin retreat pattern from the distribution of meltwater features mapped from aerial photographs and satellite images. Field work will include "ground thruthing" of image interpretations and GPS measurements of shoreline features.

Handledare: Krister Jansson

Geomorphology

20. Undulating hilly relief and inselberg plains: can GIS tell the difference?

Sweden consists of regions with typical landform patterns that have developed during many millions of years. Two of these landform regions are the "undulating hilly relief" and the "inselberg plains". They might be different stages in a land forming sequence, or they might have formed at the same time but developed differently. To identify and describe these landform regions by statistical means in a GIS would help to further unravel the evolution history of these ancient landforms. The aim of this project is to identify, analyse and compare the undulating hilly relief and the inselberg plains concerning their morphology, bedrock types and

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major tectonic faults. This is a GIS-project with analysis of different datasets in ArcGIS. A field visit might be included.

Handledare: Karin Ebert

21. Can aero-magnetic surveys contribute to study of the links between geology and landforms?

The present Swedish land surface has developed slowly during many millions of years. Different bedrock types resulted in different large scale landforms, e.g. inselbergs and plains in northern Sweden. However, only the main links between geology and landforms are clear. The aim of this project is, with an analysis of magnetic anomalies, integrated with geology and large-scale geomorphology, to shed more light on the influence of geology on landform evolution. This is a GIS-project with analysis of different datasets in ArcGIS. A field visit might be included.

Handledare: Karin Ebert

22. Glacial eroded inselbergs in N Sweden: crag and tails or giant roches moutonnees?

The area in northern Sweden east of the mountains consists of inselberg plains. Inselbergs are large bedrock hills that have formed millions of years prior to glaciation. Of 795 inselbergs on 33 000 km² of plains, about half of them give a "streamlined" impression in the digital elevation model (DEM) and in the field. The aim of this study is to describe some of the streamlined inselbergs in detail, with the goal to illustrate the effects of glacial erosion on these bedrock hills. Were they rather reshaped to crag and tails, to giant roches moutonnees, or none of them? This is a combined GIS and field mapping project.

Handledare: Karin Ebert

23. Controls of tor formation in northern Sweden

In a recent research project there are strong indications that the important controlling factors for tor formation in the Cairngorm Mountains in Scotland are crystal grain size, joint spacing and mineral composition of the granite. Northeastern Sweden also hosts a number of well developed tors in granite, especially in the Parkajoki area, north of Pajala. In this degree project we want to see if the controlling factors for tor formation exist also in the Swedish tor areas, and hence answer the question whether these controls are universal rather than local. The project would involve a field work in northern Sweden.

Handledare: Clas Hättestrand and Alasdair Skelton

24. Geomorphological effects of land use changes in Messinia, Greece.

Since the 1945 the land use activity in Messinia, southwestern Peloponnesos, has changed. The areal extent of forests has increased and the olive groves have shifted from small, local units to large agricultural. How is slope processes and land degradation affected by these changes? Methods in this project are geomorphological mapping in air photos and satellite imagery, and GIS analysis.

Handledare: Ingmar Borgström

Kvartärgeologi

25. Tefrokronologisk datering av holocena klimatförändringar

I ett flertal torvlagarföljder i Mellansverige har holocena tefralager påträffats. Uppgiften kan utformas olika beroende på om en hel lagerföljd studeras, eller att en del av en kärna studeras i detalj exempelvis i anslutning till kända tefralager. Metoder: Tefrokronologi, humifieringsanalys

Handledare: Stefan Wastegård

26. Invandringskronologi för bentisk kalkskalsfauna till Yoldiahavet

Genom studier av varviga leror i östra Mellansverige, kan man få en exakt datering av olika arters invandring till Yoldiahavet. Förekomst av kalkskalsfauna i den varviga leran (mollusker, foraminiferer och ostracoder) kan ge exakta svar när det bräckta vattnet nådde olika delar av Yoldiahavet.

Handledare: Stefan Wastegård

27. Paleoklimat och tefrokronologi i södra Sverige under den senaste deglaciationen

Studier av tefrahorisonter och andra parametrar (t.ex. pollen, makrofossil, C/N, org. kol) möjliggör en rekonstruktion av klimatet under den senaste deglaciationen av södra Sverige, samt öppnar för möjligheter till exakt korrelation med andra klimatarkiv som t.ex. iskärnor och marina borrhärnor

Handledare: Stefan Wastegård

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Glaciology

28. Flow dynamics of outlet glaciers in the South Patagonian Icefield

The South Patagonian Icefield is the largest ice mass in the southern hemisphere outside Antarctica and one of the most dynamic icefields on Earth. Like in comparable regions in the world, glaciers in the South Patagonian Icefield are experiencing retreat and acceleration in response to changes in climate. This project aims at producing comprehensive ice velocity maps for selected outlet glaciers in order to reveal temporal changes in ice velocity and mass flow. This knowledge is essential for understanding and constraining mass changes of the South Patagonian Icefield and its contribution to sea-level rise. Ice velocities will be extracted by systematically applying automatic cross-correlation to Landsat satellite images.

Acquaintance with glaciology and remote sensing are required. Data processing skills and the capability of automating processes in a scripting language (like Perl or Python) are desirable.

Supervisor: Hernán De Angelis

29. Dynamics of glacier facies of Icelandic icecaps during the early XXI century

A warming climate does not only imposes volume changes on glaciers but also on their surface types. This project aims at deriving glacier facies maps for icecaps on Iceland during the first decade of the present century. The proposed methodology is based on the analysis of visible and near-infrared images acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS). The results will shed light into the dynamics of these icecaps and their sensitivity to ongoing changes in climate, providing a useful basis for assessing glaciological models.

Acquaintance with glaciology and remote sensing are required. Data processing skills and the capability of automating processes in a scripting language (like Perl or Python) are desirable.

Supervisors: Hernán De Angelis and Susanne Ingvander

Glaciology/Tarfala Research Station

30. Swedish glacier volumes during the Little Ice age and during the Holocene maximum in the Kebnekaise area.

How much ice existed in the Swedish Mountains during the Holocene maximum and during the Little Ice Age maximum? Are all glaciers changing their volume at similar rates? Former glacier extents can be estimated by using paleo-traces of the former glaciers, such as trim-lines and marginal and terminal moraines. In this work you will use such paleo-traces to map out former glacier extents in the Kebnekaise area. You will also be able to trace out modern glacier extents. By applying a volume-area scaling relationships the measured glacier areas can be converted into volumes and thus a change in total and individual volumes can be calculated. This work requires a good background in GIS.

Supervisors: Peter Jansson and Ninis Rosqvist

31. Swedish glacier volumes during the Little Ice age and during the Holocene maximum in the Sarek area.

How much ice existed in the Swedish Mountains during the Holocene maximum and during the Little Ice Age maximum? Are all glaciers changing their volume at similar rates? Former glacier extents can be estimated by using paleo-traces of the former glaciers, such as trim-lines and marginal and terminal moraines. In this work you will use such paleo-traces to map out former glacier extents in the Sarek area. You will also be able to trace out modern glacier extents. By applying a volume-area scaling relationships the measured glacier areas can be converted into volumes and thus a change in total and individual volumes can be calculated. This work requires a good background in GIS.

Supervisors: Peter Jansson and Ninis Rosqvist

32. Swedish glacier volumes during the Little Ice age and during the Holocene maximum in the Souther Swedish Mountains.

How much ice existed in the Swedish Mountains during the Holocene maximum and during the Little Ice Age maximum? Are all glaciers changing their volume at similar rates? Former glacier extents can be estimated by using paleo-traces of the former glaciers, such as trim-lines and marginal and terminal moraines. In this work you will use such paleo-traces to map out former glacier extents in the southern Swedish mountains. You will also be able to trace out modern glacier extents. By applying a volume-area scaling relationships the measured glacier areas can be converted into volumes and thus a change in total and individual volumes can be calculated. This work requires a good background in GIS.

Supervisors: Peter Jansson and Ninis Rosqvist

33. Relationships between atmospheric lapse rates and the 'ablation gradient' on glaciers.

How do atmospheric lapse rates influence the measured ablation gradient on glaciers? The ablation gradient shows how melting decreases with altitude and is a potentially useful tool to extrapolate melting on a glacier into areas where no measurements are made or possibly also to extrapolate melt from one glacier to another. Hence such methodology is key to any assessment of glacier change en masse. This decrease is a function of decreasing temperature in the atmosphere. The measured ablation gradient varies from year to year but also from one glacier to another. It is not clear how the measured atmospheric lapse rate and its possible variations during a summer influence the ablation gradient. This work requires statistical knowledge and skills to work in Excel, Matlab or other statistical software.

Supervisors: Peter Jansson and Ninis Rosqvist

34. Glacier terminus changes

What determines the rate of change in a glacier terminus? Glaciers change in size due to changes in climate. However, the glacier also acts as a filter that takes the climate variability and produces a response in terms of a length change. By analysing measure glacier terminus positions and the climate between measurements, it is possible to study the coupling between measured length changes and the climate. This work requires good skills in GIS as well as numerical skills to analyse climate data in statistical software.

Supervisors: Peter Jansson and Ninis Rosqvist

35. An analysis of the Kebnekaise South summit glacier in response to climate change

The Kebnekaise South summit has decreased in altitude over the period it has been observed. The summit attracts many tourists because of it being the highest point in Sweden. It is, however, only a few meters higher than the second highest summit and the bedrock surface beneath the south summit is at lower elevation than the north summit. Since the south summit is a glacier it undergoes similar changes that can be observed for surrounding glaciers. By analysing and comparing the peak measurements with the long and detailed record of mass changes recorded for nearby Storglaciären, it is possible to improve our understanding of the observed changes in the south summit glacier. This work required good numerical and statistical understanding and ability to work with statistical or numerical analysis software such as Matlab, excel or statistical packages.

Supervisors: Peter Jansson and Ninis Rosqvist

Remote Sensing/GIS

36. Evaluation of high resolution Digital Elevation Models (DEMs) over snow and ice surfaces

In recent years a number of agencies have produced global, or near global digital elevation dataset from satellite imagery. Sensors such as ASTER, TerraSAR-X and the Shuttle Radar Topography mission have been used to develop such datasets. This project will evaluate errors and bias in such dataset over glacier surfaces using topographic data from maps, GPS and other sources for comparison. Inter-comparison will be used in the absence of other data.

Handledare: Ian Brown.

Periglacial landscapes

37. Snow distribution in a subarctic peat plateau/thermokarst lake complex

Snow is an important factor, together with air temperature, for determining if permafrost can form and persist in subarctic peatlands. During recent decades, warmer temperatures and an increase in winter precipitation has been reported from many subarctic regions, including northern Fennoscandia, and permafrost peatlands have started to thaw. The aim of this project is to analyze the spatial distribution of snow within a peat plateau/thermokarst lake complex in Tavvavuoma in northernmost Sweden, and relate the snow distribution pattern to ongoing and potential future permafrost thaw and thermokarst formation. Available data for the analysis includes daily photographs taken by a stationary camera overlooking the peat plateau/thermokarst lake complex to record snow depths in different parts of the complex.

Supervisor: Britta Sannel