

# Proposal to the Svalbard Strategic Grant for realisation of activities in 2018-19 to further develop and re-inforce the Terrestrial Ecology Flagship in Ny-Ålesund

The proposal is submitted by a sub-group of the Terrestrial Ecology Flagship on behalf of the flagship

## Contribution of the programme to the Svalbard Strategic Grant (SSG)

The Ny-Ålesund Terrestrial Ecology Flagship program is one of the four Ny-Ålesund flagship programs and is aimed at coordinating and integrating the various research and monitoring activities conducted in Ny-Ålesund on tundra, lake and soil ecosystems to assess their sensitivity and resilience to change. We seek to break with the general trend that every project has its own measurement sites, and will identify a limited number of strategic locations in order to increase collaboration and reduce the environmental footprint of the activities. We will facilitate international collaboration and efficiently integrate and valorize existing data, resources, logistics, as well as the multidisciplinary expertise present in the consortium. The aim is also to develop joint research proposals. The initiative is timely as we are constantly asked for better integration of research data, logistics and activities, from our funders, EU and other initiatives like SIOS.

## General organigram and rationale of the proposed programme

While the various components of the terrestrial ecosystem in Ny-Ålesund are highly interconnected (Fig.1), they are often studied in isolation and not integrated in an ecosystem perspective. This evidently prevents to quantify coupled food web dynamics and fluxes of nutrients and organic matter between these different components.

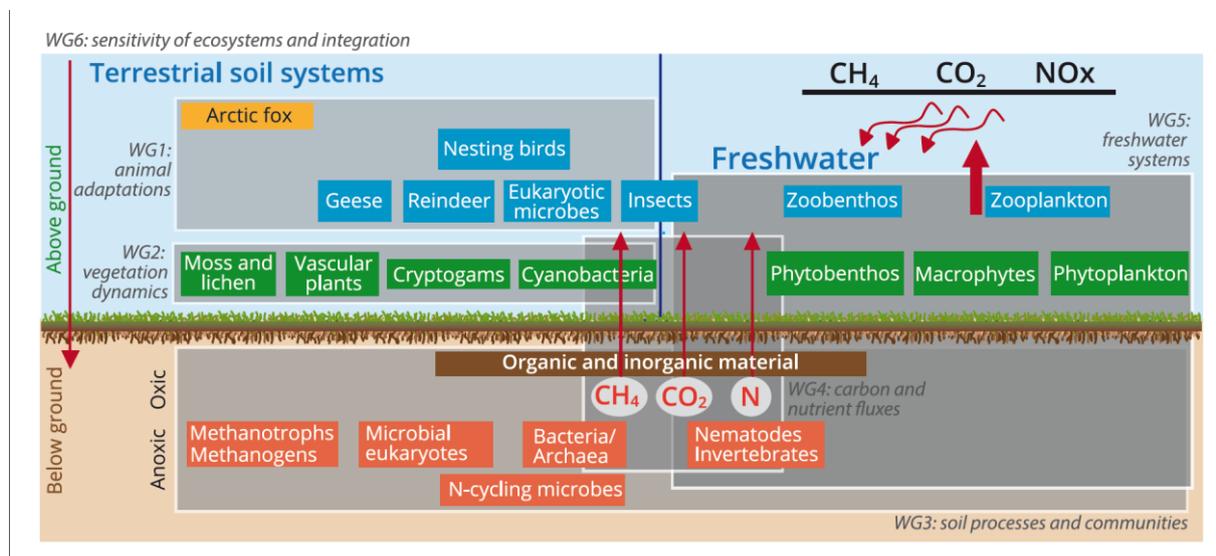


Fig. 1: Summary diagram showing the main functional groups involved in carbon and nutrient fluxes in the aboveground terrestrial ecosystems and their soils, and the lakes and wetlands and their sediments in Ny-Ålesund. Also shown are the dissolved and particulate organic and inorganic matter, and the gas exchanges and nutrient fluxes resulting from the microbial mediated breakdown and cycling of this matter. The resulting C- and N-containing gasses escape to the atmosphere and have strong feedback effects on the global climate system (Figure is modified from Ims *et al.* (2013) and Pedersen *et al.* (2016))

Within the proposed program, each of these terrestrial ecosystem components will be discussed by a working group of experts in order to integrate the existing data, and combine abiotic and biological measurements. The working groups are formed around existing research projects run by various groups or institutes in Ny-Ålesund. The group initially consists of the participants from a workshop, organized as a side-event to the Svalbard Science Conference in Oslo in November 2017, in addition to previous flagship initiatives back in time (workshop in Oslo in May 2009 where the original Terrestrial

Flagship document was written, and a follow-up in Tromsø during the Ny-Ålesund Science week in September 2015). The contributors to the working groups might change during the further development of the flagship, and the organization of the activities are open to other interested parties. Currently there has been an initiative toward Ny-Ålesund Science Manager Committee (NySMAC) to collect contact information from terrestrial researchers active in Ny-Ålesund from the various institutions, with the purpose of inviting them to join the open flagship events. The current initiative is led by the Terrestrial Flagship chair, but the responsibilities are shared among the work group leaders, that will have a special responsibility for gaining momentum for the collaboration within their theme.

The six working groups and their responsible scientists are as follows:

Workgroup 1: Animal adaptations (Åshild Pedersen and Maarten Loonen)

Previous research has revealed coupled dynamics in populations of reindeer, geese and foxes (Fuglei *et al.* 2003; Hansen *et al.* 2011; 2013) in relation to climate change related extreme weather events like rain-on-ice and the lack of sea ice. Bottom-up and top-down effects have been identified, but vary in intensity between years. In addition, the predator community for nesting birds is becoming more diverse with increasing numbers of glaucous gulls, great skuas and polar bear preying on all life stages of the birds. Insect studies have mainly focused on the presence and adaptation of individual species, but rarely been integrated in food web interactions as they are major components of the diet of some birds. This working group will focus on the interaction among monitored species and the interaction with other working groups on factors determining population size. COAT forms the basis for this working group and will specifically address the reindeer-fox-barnacle goose-vegetation interactions.

Workgroup 2: Vegetation dynamics (Masaki Uchida and Angela Augusti)

Tundra vegetation is usually a mixture of vascular plants, mosses, lichens, cyanobacteria and microscopic algae, each adapted to local conditions in the microclimate, nutrient concentrations, hydrology, biological interactions and other chemical and physical soil characteristics. Studies on individual plant adaptations, succession, diversity, functional groups and the effects of snow, ice and grazing have been performed on different scales from small plots to the landscape level with remote sensing. The aim of this working group is to reach out specifically to the other working groups with data already collected and determine knowledge gaps to understand dynamics and interactions within the terrestrial ecosystem.

Workgroup 3: Soil processes and communities (Mette Svenning and Stefano Ventura)

The soil is full of biological activity, including the breaking down of organic material, which in turn affects nutrient availability and modifies gas emissions. Microbial biodiversity and activity can be studied by using DNA profiles. The interface between anoxic and oxic conditions and the transition between frozen and unfrozen ground have shown to be important regulators. Moreover, biological soil crusts with primary producers like cyanobacteria and microalgae influence the hydrological and thermal properties of the soil and potentially prepare the substrate for the colonization by mosses and higher plants. This working group will focus on soil processes which are determined by permafrost, hydrology and organic material and affect the activities of the other working groups.

Workgroup 4: Carbon and Nutrient fluxes (Angela Augusti and Masaki Uchida)

Future emissions of CO<sub>2</sub> and CH<sub>4</sub> are forecasted to increase as a result of rising air temperatures and their effect on permafrost through both the physical release of GHGs from unfrozen soil and the increased soil microbial metabolism. On the other hand, the contribution of vegetation in sequestering CO<sub>2</sub> should also be considered. Measurements of gas fluxes at the ecosystem, the plot and the soil level, in particular at different soil depths, can be directly related to results obtained by the other WGs focussing on vegetation dynamics, soil processes and communities and freshwater systems. This is because in particular for CO<sub>2</sub>, the contribution of higher plants, of other photosynthetic organisms and

of soil microbial respiration will contribute to carbon flux dynamics. Due to the tight connection between vegetation, microbial metabolism and nutrient fluxes, nitrogen fluxes will be analysed both in soil and in living organisms and the resulting flux calculations will be used for predicting the future response of the different components of the terrestrial ecosystems.

#### Workgroup 5: Freshwater systems (Elie Verleyen, Dirk Mengedoht, Josef Elster)

This work group will provide the needed baseline data on the biodiversity and functional genetic make-up of freshwater communities in the water column, the benthos and the sediments of lakes, wetlands and rivers. In addition, the WG will develop projects to quantify the effects of internal and external factors on the food web structure in freshwater systems and their ecosystem functions, including primary production, nutrient dynamics, and the microbial mediated conversions of allochthonous and autochthonous organic matter into greenhouse gasses (i.e., CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O). The internal and external factors include vegetation dynamics in response to the activity of terrestrial grazers (WG1 and WG2), as well as changes in temperature, water column stability, the moisture balance, and snow and ice cover. Lakes are also integrators of these changes, and can therefore be used to reconstruct long-term variability in the terrestrial environment by analyzing biological and biogeochemical proxies in their sediments. This can provide a context of natural variability against which recent and future changes in terrestrial and lacustrine ecosystems can be compared.

#### Workgroup 6: Sensitivity of ecosystems and integration (Maarten Loonen and Elie Verleyen)

While the other workgroups focus on bridging knowledge gaps within compartments and providing relevant data for other compartments of the ecosystem, this workgroup will focus on (i) an overall integration of processes and fluxes, (ii) studying the sensitivity and resilience of the terrestrial biome in Ny-Ålesund to climate change, and (iii) considering different levels of ecosystem organization by taking levels of space and time into account. A scientific review and opinion publication will be an important product of this WG. This workgroup will also develop links with the other flagships in Ny-Ålesund and SIOS to ensure an efficient description, storage and exchange of data. This group will work following a cyclic process of gathering information from the other working groups, providing an integration, describing knowledge gaps and subsequently disseminating their conclusions to the relevant working groups. This working group will also be responsible for outreach and education of the results and the overarching insights obtained by the terrestrial flagship program.

#### **Planned activities in 2018-2019 – Implementation plan**

Two workshops are planned within the proposed project:

Workshop 1: During a first workshop in Ny-Ålesund (August 2018), the principal scientists will present their ongoing terrestrial research in Ny-Ålesund and the field sites under study will be visited. The visits to the various locations and research activities will offer an opportunity for developing integrated ecosystem studies. Below we list some of the sites and the main state variables which are presently collected:

- CCT-tower (CRNS): climatic and environmental parameter measurements, vegetation and permafrost observations;
- Permafrost site (AWIPEV): with automatic instruments that currently also measure gas exchange;
- Snow fences manipulating snow accumulation and studying vegetation and soil microbes
- Permanent transects along gradients in moisture availability, studying soil processes and microbial biodiversity;
- Enclosures build by NPI for reindeer studies and by UiG for goose grazing studies, studying vegetation change;
- Glacier retreat gradient used for studies on nitrogen fixation and insect succession;
- Lake Solvatnet, Brandalpunkten and on Knudsenheia with measurements on microbial activity and plankton diversity;

- Vegetation plots from NERC with temperature, water and nutrient additions;
- Vegetation manipulation with open top chambers to study soil fungal biodiversity by NERC;
- Vegetation monitoring sites at several places around the fjord with measurements of microbial diversity by PRIC;
- Gas exchange measurement plots at bird cliffs Stuphallet and Brøggerhalvøya by NIPR;

In 2018/2019 COAT (Ims *et al.* 2013) will implement sites for long-term ecosystem studies, which build on and expand the existing long-term monitoring done by Norwegian Polar Institute in and around Ny-Ålesund. Automated stations will act as focus points for a landscape level analysis of above-ground terrestrial ecosystem interaction (e.g. reindeer, fox, geese and vegetation interaction). These will enable real time detection, documentation and understanding of climate impacts on Arctic tundra ecosystems.

This on-site workshop will, despite being organized in Ny-Ålesund, contribute to reduced environmental footprint since one of the aims is to coordinate field-activities, and potentially reduce the number of different plots and sites. We consider a visit to field sites being essential to choose the optimal sites for the integration of the different studies.

The outcome of this workshop should be a concrete plan for better integration of field studies and the development of a joint strategy to obtain complementary data for a wider range of research sites. The deliverables of the first workshop will be a scientific paper on the relevance of an integrated ecosystem approach with an overview of identified trophic links within and between ecosystems and relevant parameters. The focus of this paper will be on annual variability, gradual changes and ecosystem resilience. Furthermore, the first workshop should result in a description of data (metadata), which should become available for cross working group analysis, and feed into other initiatives like SIOS data portal, RiS and GBIF. Scientists conducting research relevant to the terrestrial flagship program in other regions of Svalbard will be identified in preparation of the second workshop. Positions and collaborators can be re-considered.

Workshop 2: The second workshop will be organized in Longyearbyen (August 2019). The data obtained within the six working groups will be integrated and used to (i) make links to other flagship programs, and (ii) discuss possibilities for collaborations with terrestrial research projects outside Ny-Ålesund, such as the terrestrial ecosystems in Longyearbyen where Josef Elster, and Hornsund where Alfred Stach (both project partners) are conducting research. The results from the workshops should be highly relevant for SIOS, as an integrative platform for Svalbard research and a data portal. The studies on annual variability, gradual change and ecosystem resilience will generate new knowledge that is relevant for management and conservation efforts of the terrestrial ecosystem in Svalbard. As a long term perspective, the Ny-Ålesund Terrestrial Flagship should develop further into a relevant entity of research groups to take a leading role for coordinating terrestrial field work in Ny-Ålesund for initiatives like SIOS and INTERACT. The flagship should enhance cooperation and data sharing and work towards the development of new and integrated project proposals to the EU.

The Flagship maintains a webpage under the NySMAC webpage: <http://nysmac.npolar.no/research/flagships/terrestrial.html> where information on events, work-groups and other relevant issues will be posted.

### **Data handling and sharing plan**

The Terrestrial Ecology Flagship will contribute to SIOS metadatabase by collecting available metadata on on-going long-term monitoring as a first step. By making information on already existing time-series visible and available, collaboration is expected to increase, and duplicate activities can be avoided. We will also ensure that our data will be made publically available through GBIF and ensure the data and

metadata meet the Darwin core standard. More details on data handling and sharing can be found in the dissemination plan.

## **Budget**

### **Direct costs**

#### **Meeting in Ny-Ålesund in August 2018: 25 pers., 4 days**

Travel LYB-NyÅ: 25 pers. x 6kNOK = 150 kNOK

Board NyÅ: 25 pers. x 600NOK x 4 nights = 60 kNOK

Meeting room: 16 kNOK

Total: 226 kNOK

#### **Meeting Longyearbyen in August 2019, 40 pers., 4 days**

Lodging LYB (UNIS guest house): 40 pers. x 1300 NOK x 4 nights= 208 kNOK

Meeting room and coffee: 40 pers. x 250 NOK x 4= 40 kNOK

Total: 248 kNOK

### **ADM (5%)**

Total: 24 kNOK

**Total direct costs: 498 kNOK**

### **In kind costs**

#### **Meeting in Ny-Ålesund in August 2018: 25 pers., 4 days**

Room in NyÅ: 25 pers. x 650NOK x 4 nights= 65 kNOK

Travel to LYR: 25 pers. x 6kNOK= 150 kNOK

Total: 210 kNOK

#### **Meeting Longyearbyen in August 2019, 40 pers., 4 days**

Meals in LYB: 40 pers x 750NOK x 4 nights = 120 kNOK

Travel to LYB: 40 pers x 6kNOK = 240 kNOK

Total: 360 kNOK

**Total in-kind: 570 kNOK**

The total support requested by the Svalbard Strategic Grant is NOK 498 kNOK. This amount will be matched with in-kind contributions of over 570 kNOK.

## **Literature used**

Coulson, S., G.W. Gabrielsen, C. Hübner, M.J.J.E. Loonen (2009) Terrestrial Ecosystems – a flagship programme for Ny-Ålesund. Concluding document from workshop 6-8 May 2009. Norwegian Polar Institute Brief report Series no. 20

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Hansen, B. B., Grotan, V., Aanes, R., Saether, B., Stien, A., Fuglei, E., ... Pedersen, Å. Ø. (2013). Climate events synchronize the dynamics of a resident vertebrate community in the high Arctic. *Science* 339: 313-315.

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Pedersen (2016). Report from the 12th Ny-Ålesund Seminar, Tromsø, Norway, 23-25 September 2015. Norwegian Polar Institute Brief Report no. 036.