

Project information

Keywords

Arctic, sub-Arctic, climate change, winter warming, air pollution, multistress, nitric acid, ecophysiology

Project title

Winter disturbance and nitrogen pollution: Unraveling the mechanisms behind ecosystem response to combined effects of climate and pollution (WINNIT)

Year

2015

Project leader

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Participants

Current project participants from Fram Centre institutions: Dr. Stef Bokhorst, NINA; Dr. Hans Tømmervik, NINA; Dr. Laura Jaakola, University of Tromsø & NIBIO; Dr. Matthias Zielke, freelance; Dr. Marit Jørgensen, NIBIO, Jon Schärer, NIBIO, Dr. Katja Karppinen (postdoc at Oulu University, with internship at Jaakola's lab, and on a short-term contract with NINA for expert assistance on gene expression).

Other participants: scientists from Vrije Universiteit Amsterdam and University of Sheffield

Flagship

Terrestrial

Funding Source

Research Council of Norway (2013-2016): 6215 KNOK

Summary of Results

This summary builds on the two previous summaries (autumn 2013 and 2014) and focuses on activities from October 2014 onwards. We conducted the field manipulation experiment for a second time in February 2015 in accordance with the project plan. During the growing season, we quantified changes in plant and soil invertebrate communities. We are currently analyzing these data, and a manuscript is under preparation. At present, the data suggest that there have not been any specific treatment effects. This stands in contrast to a similar experiment performed in northern Sweden (however, there without the additional nitrogen treatment). The difference may be related to the snow and temperature regime after the warming treatment; in Tromsø the ambient temperatures were not as cold as in northern Sweden. Another factor to consider is an outbreak of geometrid moth caterpillars that affected heavily the field site through leaf defoliation during the summers of 2014 and 2015. This may have masked any potential impact of the winter warming event and nitrogen treatments.

Analyses of the fatty acid composition and gene expression of frost resistance genes from the controlled climate chamber and freezing experiment is still under way, and we plan to have these analyses finalized before New Year. Preliminary results on expression of the frost resistant genes show high responses to the some of the treatments. Two publications are in preparation on the physiological

responses to, and mechanisms behind, the vulnerability of plants and cryptogams to extreme winter warming events and nitrogen pollution. Initial results indicate that, as expected, evergreen plants are more vulnerable to extreme winter warming events than deciduous plants and that this group of plants does not change the fatty acid composition during winter temperature variability.

In the first scientific article from this project, published in the journal *Global Change Biology* earlier this year, we show that evergreen dwarf shrubs will be disadvantaged in a future sub-Arctic with more stochastic climatic and biotic events, such as extreme winter warming and caterpillar outbreaks. This is of particular concern given that sub-Arctic and Arctic heath vegetation is typically dominated by evergreen shrubs. Together with a large international consortium, we are authoring a scientific review on Arctic winter snow changes, which will include recommendations for science and society. Our ambition is that this work can serve as a guideline for observing, modelling and determining impacts. This work was recently submitted to an international journal with Bokhorst as lead author.

Knowledge from this project has been valuable for two recently published scientific assignment reports. The first report was done for the Norwegian Environment Agency and published in NINA's report series. It dealt with habitat types vulnerable to climate change. The second was a policy brief published by the Nordic Council of Ministers and dealt with long-range air pollution, including nitrogenous compounds.

We have had extensive outreach activities in this period. This includes a 5-minute long video presentation of the project in English. This video was posted at several websites, including Science Nordic. We have authored an article on springtails that will be published soon in the popular science magazine *Ottar*. In November last year, Bjerke was interviewed live on the national radio channel NRK P1 about impacts of winter climate change on plant life. He was also interviewed by forskning.no in their series "Under tellekanten". Results from the project were presented on the public Science Days in Tromsø. Finally, we have presented results from the project to the scientific community on several occasions.

For the Management

Increasing the understanding of how ongoing and future global change affect and will affect ecosystems and society is one of the major tasks for the scientific community of today. In this context, WINNIT is providing valuable new information on how northern lands will be affected by the combined effects of pollution and climate change, and what the future may look like. Such results should be used by public management bodies in their efforts to make realistic action plans for adaptation to future changes, and to assess the climate regulation services of northern lands.

Published Results/Planned Publications

Bokhorst S., Phoenix G.K., Berg M.P., Callaghan T.V, Kirby-Lambert C. & Bjerke J.W. 2015: Climatic and biotic extreme events moderate long-term responses of above- and belowground sub-Arctic heathland communities to climate change. *Global Change Biology* 21: 4063–4075. DOI: 10.1111/gcb.13007.

Aarrestad P.A., Bjerke J.W., Follestad A., Jepsen J., Nybø S., Rusch G. & Schartau A.K. 2015: Naturtyper i klimatilpasningsarbeid. Effekter av klimaendringer og klimatilpasningsarbeid på naturmangfold og økosystemtjenester. *NINA Rapport* 1157. 98 s. ISBN: 978-82-426-2781-0.

Karlsson P.E., Hole L.R., Tømmervik H. & Kobets E. 2015: Air pollution in the Nordic countries from biomass burning in Eastern Europe. Policy Brief. *ANP Series* 776. ISSN: 978-92-893-4297-1.

Communicated Results

See last year's report for 26 items of results communicated until October 2014. Here, we list communicated results from the last 12 months.

Bjerke J.W.: Milde vintre skader planter. *Interviewed on the live show "Norgesglaset" at NRK P1 Radio*, 12 November 2014.

Bjerke J.W.: Impacts of contrasting snow, ice and soil frost conditions on northern primary productivity – insight from manipulative and observational studies. *Lecture at: Fram Centre, the terrestrial flagship's thematic day on snow: Measuring, remote sensing and modelling snow properties important for northern ecosystems*, 28 November 2014, Tromsø.

Bokhorst S., Berg M.P., Wardle D.A., Gundale M.J., Nilsson M.-C., Phoenix G.K., Callaghan T.V. & Bjerke J.W.: Climatic versus biotic impacts on soil micro-arthropods. *Poster at: The First Global Soil Biodiversity Conference, Global Soil Biodiversity Initiative*, Book of abstract P1.023, 2-5 December 2014, Dijon, France.

Tømmervik H. & Bjerke J.W.: Reinbeiter og klimaendring. Hva skjer med reinbeitene i Trøndelag når vintrene blir mildere og vekstsesongen lengre. *Lecture at: Reindriftskonferansen 2015*, 2-3 March 2015, Tingvoll.

Markusson H.: Lykken er en ny art. *Interview with Jarle W. Bjerke in the series «Under tellekantent» at forskning.no*: <http://forskning.no/klima-planteverden/2015/03/lykken-er-en-ny-art>, 6 March 2015.

Bokhorst S.: Impacts of changing winter snow conditions for Arctic ecosystems. *Lecture at: Arctic Science Summit Week*, The International Arctic Science Committee, 23-30 April 2015, Toyama, Japan.

Bokhorst S.: Direct and indirect impacts of climate warming in the Polar regions. *Lecture at: 9th meeting of the Scientific Steering Committee for the Dutch research facility in Antarctica (The Dirck Gerritsz Laboratory)*, 15 May 2015, Texel, The Netherlands.

Schärer J., Bokhorst S. & Bjerke J.W., Jaakola L. & Jørgensen M.: Northern nature under stress. *Video report in English, accompanied by additional text and photos, and published at several websites*, 18-29 May 2015: http://www.bioforsk.no/ikbViewer/page/forside/nyhet?p_document_id=121676 <http://www.framshorts.com/video/winnit-northern-nature-under-stress/?fancy=true>
<http://www.nina.no/Forskning/Prosjekter/Vinterklima/WINNIT>
<http://sciencenordic.com/northern-nature-under-stress-0>

<https://vimeo.com/127428914>

Tømmervik H., Johansen B., Strand O., Park T., Fauchald P., Myneni R. & Bjerke J.W.: Arctic biomass: Greening and browning in the Arctic – implications for reindeer and caribou. *Lecture at: 14th International Arctic Ungulate Conference*, 16-21 August 2015, Røros.

Treharne R., Bjerke J.W., Tømmervik H. & Phoenix G.K. 2015: Arctic browning: vegetation damage and implications for carbon balance. *Poster at: UK Arctic Science Conference 2015*, 16-18 September 2015, Sheffield, UK.

Halvorsen L.H., Elverland E., Bjerke J.W., Jørgensen M., Steindal A.L.H., Halland H.: Viktige kilder til mat i nordnorsk landbruk og natur: potet, bær og bygg. *Stand at: Forskningstorget, Forskningsdagene*. 25-26 September 2015, Tromsø.

Jørgensen M.: -Kult med forskning. *Interviewed by the newspaper iTromsø*. Reporter: Vuolab S. E., <http://www.itromso.no/nyheter/article11613999.ece>, 26 September 2015.

Bjerke J.W.: Increasing climatic and biotic disturbance severity – can we influence the direction of Arctic vegetation change, and if so, which direction should we promote? *Lecture at: 'ArcticBiomass' Final Workshop, open programme*, 21 October 2015, Longyearbyen.

NINA: WINNIT: <http://www.nina.no/Forskning/Prosjekter/Vinterklima/WINNIT> (frequently updated website in Norwegian).

Interdisciplinary Cooperation

WINNIT has partners from various fields of biological sciences, including ecophysiology, microbiology, biochemistry, ecosystems ecology, pollution biology, animal ecology, soil biology, physical geography (earth observation), and global change biology. These partners are familiar with interdisciplinary and international research, and this cooperation runs smoothly so far.

Budget in accordance to results

As our lists above and our previous reports show, we have had extensive public outreach activity. Such wide extent would have been impossible without the flagship funding. We have hired Jon Schärer to make science videos from the project. During this last period, we published a video report in English. This video was posted at five websites: NIBIO, Framshorts, NINA, Science Nordic and Vimeo.

The extra funding has also opened up a possibility for Bokhorst and Bjerke to take part in the interdisciplinary initiative by IASC, INTERACT, AMAP, CliC and GEO to develop a future science plan for Arctic climate change in relation to snow, a process which was initiated at the Copenhagen workshop in October 2015. A review manuscript on impacts of snow season on all aspects of Arctic life has recently been submitted to an international journal, with Bokhorst as lead author.

Overall, the project partners have had the possibility to dedicate more time to WINNIT activities thanks to the flagship funding. This will at the end of the project be visualized through a higher number of scientific publications, and we are already seeing the positive results of the funding on public outreach activities, both in terms of quality and number of initiated campaigns. Another activity not mentioned above is the completion of an article for Tromsø Museum's popular science magazine Ottar. The article is about how springtails respond to changing winter climate, including a general introduction. We have finished this article, and it will be published in 2016.

Could results from the project be subject for any commercial utilization

No

Conclusions

This conclusion is written in light of the guidelines given in last year's form, namely: "a) Indicate future research and/or perspectives which the project results have led to;

b) List and describe new methods or techniques that have been developed during the project or that the project has revealed a need for".

- a. During the preparation of the WINNIT project, we noticed the need for more for more multistress approaches in climate-change-related field experiments. These ideas also developed into another research proposal, which got international funding, and which now is part of this same flagship consortium; see the WICLAP project. We are continuously developing these ideas, building on previous results, and hope to find funding for related themes in the years to come.
- b. We are using experimental methodologies that have not been much used previously. For example, we are the only group that uses an array of infrared heaters for actively thawing snow and warming up vegetation plots in winter. We are also developing tools for gene expression analyses of species that until this project have not been tested using gene expression. We are also exploring the utility of new sensors for assessments of plant health and vitality.