

## Project information

### Keywords

Arctic, climate change, winter disturbance, pollutants, multistress, Svalbard, Poland, vegetation

### Project title

Ecosystem stress from the combined effects of WInter CLimate change and Air Pollution - how do the impacts differ between biomes? (WICLAP)

### Year

2015

### Project leader

Jarle W. Bjerke

### Participants

Current project participants from Fram Centre institutions: Dr. Hans Tømmervik, NINA; Dr. Dagrur Vikhamar Schuler, Meteorologisk institutt. Associated partner: Stein Rune Karlsen, NORUT. In addition, partners from Poland and University of Sheffield.

### Flagship

Terrestrial

### Funding Source

The EEA Poland-Norway Grant with call deadline in November 2012.

## Summary of Results

For the academic communication of results, we expect to publish our results in peer-reviewed journals and share our findings in conference presentations and proceedings. Of course, this will primarily occur towards the end of the project after data collection and analysis, meaning that most manuscripts will be completed in 2016. We have already presented the project and project results on various occasions, including in the science magazine “International Innovation”, and we have published two articles and two short reports. In the first article by Tømmervik et al. (2014; see under “Published results” for full reference), we show that unmanned aircraft systems are an effective tool for monitoring of Arctic vegetation composition and performance on multiple scales.

In the second article by Kłos et al. (2015), we review the research, and present novel results, on the accumulation of heavy metals in mosses from Poland and Spitsbergen. From an Arctic point of view, the most important result from this study is the high concentrations of nickel (Ni) in mosses from Longyearbyen, Adventdalen and Bjørndalen. Svalbard coal contains high amounts of Ni. We therefore assume that windblown coal dust from the mining industry is the primary source for Ni. We also show that heavy metal concentrations have decreased considerably at Polish sites close to industrial centres, clearly indicating reduced short-distance-dispersed air pollution.

A manuscript based on results from the climatological work package was recently submitted to an international journal (Vikhamar-Schuler et al.). To identify historical frequencies of winter warming events, we applied the longest available high-quality observation series from Nordic weather stations

north of the Arctic Circle. We show that all stations had very high frequency of warm winter weather events during the 1920s and the 1930s, corresponding to the Early 20<sup>th</sup> Century Warming period. High frequencies were also detected for the last 15 years. Our projections for the next 100 years suggest an increase of winter warming events with 200-300 %, depending on station. We also review current and potential impacts on society and nature.

Additional results are being analysed and will be communicated later.

For the Management

This project addresses several priorities of international climate and pollution agendas. The studies will contribute our knowledge on an understudied, but highly important, element of climate change, namely the frequency, magnitude and spatial extent of winter warming events and their impact on ecosystem health at different latitudes. Parallel studies of ecosystem pollution by heavy metals and other types of pollutants, and temporal variability in ecosystem pollution, enhance our knowledge of the combined stressors of climate change and air pollution on different biomes. Knowledge of biological and societal consequences of these phenomena will be enhanced, and the most vulnerable and stressed areas and ecosystems will be identified.

As the project relates to climate and pollution at several levels – from extremes histories, via impacts on natural ecosystems and agroecosystems, to impact projections for the future – the results are of high relevance to the population at large in both countries involved and the entire EU, the nature management and agricultural sectors, and to the development of industry and livelihood.

Published Results/Planned Publications

**Kłos A., Bochenek Z., Bjerke J.W., Zagajewski B., Ziolkowski D., Ziembik Z., Rajfur M., Dolhańczuk-Śródka A., Tømmervik H., Krems P., Jerz D. & Zielińska M.** 2015: The use of mosses in biomonitoring of selected areas in Poland and Spitsbergen from 1975 to 2014. *Ecological Chemistry and Engineering S* 22 (2): 201–218. DOI: 10.1515/eces-2015-0011.

**Tømmervik H., Karlsen S.R.,** Nilsen L., Johansen B., Storvold R., Zmarz A., Beck P.S., Johansen K.S., Høgda K.A., Goetz S., Park T., **Zagajewski B.,** Myneni R.B. & **Bjerke J.W.** 2014: Use of unmanned aircraft systems (UAS) in a multi-scale vegetation index study of Arctic plant communities in Adventdalen on Svalbard. *EARSeL eProceedings* 13, S1: 47–52. DOI: 10.12760/02-2014-1-09.

**Tømmervik H., Bjerke J.W., Karlsen S.R.,** Storvold R., Thuestad A., Johansen B. & Høgda K.A. 2015: Monitoring human and climate change-induced plant stress in the Nordic Arctic Region and Svalbard using remote sensing and field surveys. *Brief Report Series* (Norwegian Polar Institute) **32**:

**Zagajewski B., Wietecha M.,** Ochtyra A., Kycko M., Orłowska K., **Bochenek Z., Ziółkowski D.,** Bartold M., **Tømmervik H., Bjerke J.W., Kłos, A., Ziembik Z., Vikhamar-Schuler D.,** Jarocińska A.M., Romanowska E., Marcinkowska A., Sabat A., Robak A. & **Golenia M.** 2014: Spectral properties and condition of dominant forest tree species. *In: European remote sensing - new opportunities for science and practice.* 34th EARSeL Symposium, abstract and programme book, pp. 214-215. ISBN 978-83-63245-57-3.

Communicated Results

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.*

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.*

Karlsen S.R.: Growing season and primary production mapped by MODIS and Landsat 8 data on Svalbard. *Lecture at: 'ArcticBiomass' Final Workshop, open programme, 22 October 2015, Longyearbyen.*

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

Tømmervik H., Bjerke J.W., Karlsen S.R., Thuestad AE., Storvold R., Johansen B. & Høgda K.A.: Monitoring man- and climate change-induced plant stress in the Nordic Arctic Region and Svalbard using remote sensing and field surveys. *Lecture at: Assessing vulnerability of flora and fauna in polar areas.* Norwegian Polar Institute, 3 November 2014, Tromsø.

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

Vikhamar-Schuler D., Isaksen K., Haugen J.E., Tømmervik H., Luks B. & Bjerke J.W.: Changes in winter warming events in the Nordic Arctic Region. *Lecture at: EGU General Assembly Conference*, 14 April 2015, Vienna.

Vikhamar-Schuler D., Isaksen K., Haugen J.E., Tømmervik H., Luks B. & Bjerke J.W.: Changes in winter warming events in the Nordic Arctic Region. *Lecture at: 3rd Conference on Modelling Hydrology, Climate and Land Surface Processes*, 7 September 2015, Lillehammer.

WICLAP consortium: WICLAP website: [www.wiclap.eu](http://www.wiclap.eu) (frequently updated project website with news)

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

#### Interdisciplinary Cooperation

The project consortium includes researchers from several disciplines: meteorology-climatology, physical geography – especially related to earth observation, chemistry, ecology, and physiology. This interdisciplinary cooperation is running smoothly and has already been manifested in research articles. An interdisciplinary approach was a prerequisite for the EEA call. For the last period of the project, we will put much emphasis on integration of results for multidisciplinary research articles, and we may also involve researchers from social sciences for further expansion of the interdisciplinary approach.

#### Budget in accordance to results

The funding obtained from the Terrestrial Flagship has allowed us to undertake more extensive field data sampling than would have been possible without this funding. This is an quintessential addition, especially in light of the slightly reduced funding from EEA without allowing to reduce ambitions of the project plan, and increasing costs of doing fieldwork in Svalbard. With additional working hours, we have been able to involve more young researchers in the project, including a UK PhD student. We have also had time to do more public outreach activities.

Could results from the project be subject for any commercial utilization

Yes

If Yes

Our Polish partners at the Institute for Geodesy and Cartography (IGiK) have as one of their main role to develop commercial products relevant for environmental and agricultural sectors. This project helps them to improve their earth observation-based products, and this is in line with the EEA call, namely to enhance the competence of Polish institutions in their fields of expertise.

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. In relation to climate change, this project has further elucidated the nature and impacts of winter climate change (mostly unpublished, parts of data in submitted manuscript). We conclude that winter climate change will be a strong driver of Arctic terrestrial ecosystem change in the coming decades. This should be assessed further. In relation to pollution, we have found that Svalbard plants and soils are much more contaminated than expected. This may have impacts on the welfare of vegetation, animals and humans in and around Longyearbyen, and this should be scrutinized in further detail.
- b. See under "commercial utilization" for information. We are constantly assessing ways to improve methods and techniques. We are among the first users of newly developed hand-held sensors. We see ways these can be used and also have ideas for how these devices can be further improved. These are issues we will discuss in future articles and directly with the producers of these devices.