

Project information

Project title

Extreme Winter Warming in the High North and its biological effects in the past, present and future (EWWA)

Year

2013/2014

Project leader

Jarle W. Bjerke, NINA

Participants

- Project leader: Dr. Jarle W. Bjerke, NINA

Current project participants from Fram Centre institutions:

- Dr. Hans Tømmervik, NINA
- Dr. Eirik Malnes, NORUT
- Dr. Jan Åge Riseth, NORUT
- Dr. Marit Jørgensen, Bioforsk Nord
- Dr. Matthias Zielke, Bioforsk Nord
- Prof. Arve Elvebakk, University of Tromsø
- Dr. Stef Bokhorst, NINA.

Other participants: Terry V. Callaghan, Gareth K. Phoenix, University of Sheffield; Cecilia Johansson, Uppsala University; Dagrun Vikhamar-Schuler, Jan Erik Haugen, Ketil Isaksen, Meteorological Institute Norway.

Flagship

Terrestrial, Theme: Ecosystem effects of extreme climate events and changing seasons

Funding Source

Fram Centre, NRC

Summary of Results

This project is now a little bit more than half way. We are on schedule concerning our objectives of understanding the effects of changing winter climate by means of results from experimental studies and analyses of natural events. Numerous tasks have been completed, or are being handled. This includes monitoring and modeling of snow and ice dynamics; compilation of information on natural events dating back to the 19th Century; interviews with reindeer herders possessing valuable traditional ecological knowledge; remote sensing assessments of winter disturbance effects on growing season greenness of northern lands; running of winter warming experiments in the field and under controlled environmental conditions in climate chambers; monitoring of recovery in winter-damaged fields in Abisko and along a Swedish-Norwegian transect; trend analyses of North-Norwegian time series of frozen ground and claim settlements to affected farmers; field surveys of recent ecosystem damage from winter weather events; trend analyses and modeling of meteorological observations; contact with the media; and scientific dissemination of results.

Currently, the project has contributed to five scientific publications, meaning three additions to the 2012 report list. Project partners Bjerke, Bokhorst, Callaghan, Zielke and Phoenix made a study of how bryophytes and lichens respond to midwinter warming events. The results show that they respond quickly and reach positive photosynthesis rates within very short time after thawing, and are not as dormant under the snowpack as previously assumed. The results were published in the journal *Plant Ecology & Diversity*. Two of the project partners (Tømmervik and Callaghan) joined a consortium of a total of 21 scientists, who analyzed changes in temperature difference between seasons and the concomitant change in seasonality over northern lands in the period 1982-2011. Extension of the growing season (Photosynthetic Active Period - PAP) was detected for 88 % of the Arctic region and 81 % of the boreal region and was on average estimated to be more than 3 days per decade. The results show that winters indeed have warmed more than summers, and this has made seasons become less different from each other. In addition, increased plant growth (greening) was shown in 32 % to 41 % of the Arctic and boreal regions, while browning trends were evident in about 5 % in both regions. The results were published in *Nature Climate Change* and have received massive media coverage. One of the authors has tried to keep track of all citations on news websites and in printed media, and the number of hits in English sources are currently around 263.000. The results have also been much cited by the Norwegian press, including front coverage in *Aftenposten* (7 April 2013).

Callaghan, Bokhorst, Phoenix, Bjerke and Tømmervik contributed to a synthesis of observations of ecosystem change within an intensively studied area, namely the Abisko region in northern Sweden, published in *Philosophical Transactions of the Royal Society, B, Biological Sciences*. The synthesis analysis show that the processes regulating ecosystems are complex and that a great number of drivers contribute to stabilize or change ecosystem states. This synthesis is unique, because it compiles observations from numerous sources, and because such synthesis at such level of detail has never previously been made for any northern area.

The project partners have had extensive outreach activity during the report year. For example, we have produced two internet video news features, both accessible from forskning.no – the much-read Norwegian website for science news. The first video, named “The spring is waiting beneath the ice”, deals with last winter’s severe ground-ice accumulation and possible effects on plant vitality. The second video, named “Extreme weather events put much stress on northern nature”, is about winter disturbances in general and how these may cause

much vegetation damage. Further, we have given interviews to radio and newspapers – including *VG*, *NRK Nordpå*, *Barents Observer*, *Stavanger Aftenblad*, and *Nordlys* – about our published results, or asked for expert comments on winter issues.

For the Management

This project emphasizes the past and future frequency and severity of winter warming events and their impacts on snow and ice cover, agroecosystems and natural ecosystems. This project therefore consists of a truly multidisciplinary network with intersectorial cross-cutting between science, industry and society. As the project relates to winter climate change in the High North at several levels, it is of high relevance to the population at large, the nature management and agricultural sectors, and development of industry and livelihood.

Increasing the understanding how on-going and future climate change affects and will affect ecosystems and society is one of the major tasks for the scientific community of today. In this context, EWWA is an important contributor by supplying new information on how northern lands will be affected, and what the future will look like. In addition to having main focus on changing winter climate, the additional Fram Centre funding has made it possible to also focus on other seasons of the year and to other disturbance events, thereby rendering a more complete understanding of the total drivers of ecosystem change. The synthesis paper published in Proceedings of the Royal Society (see above) is an example of this. We are also preparing additional papers on multiple disturbance effects.

The management needs to get a better understanding of the complexity of drivers causing ecosystem change in order to develop realistic action plans. EWWA will provide them with valuable data.

Knowledge from EWWA was also used in a NINA report (<http://www.nina.no/archive/nina/PppBasePdf/rapport/2013/959.pdf>) to the Norwegian Environment Agency on potential effects of spruce planting on ecosystems and biodiversity. In the report we state that planting of Norway spruce probably will not have the same productivity in the future as today, because of increased risk for climate-induced injuries. This arises from results from EWWA (and its predecessor – and published results from other projects) showing that wintergreen plants are most vulnerable to winter disturbance. Recently, the new Minister of Environment Tine Sundtoft stated that it is rather unlikely that the Government will subsidize increased spruce planting, as scientific data suggest it is not a good idea (<http://www.aftenposten.no/nyheter/iriks/Regjeringen-gir-rodt-kort-til-pobelgrana-7366015.html>). It is likely that the decision is partly based on our report. This is a good example on how climate change data have direct implications for political decisions. In this case, Bjerke actively used Twitter to broadcast scientific results, without being political in the content of the tweets. Among the followers are important Norwegian governmental institutions. Whether Bjerke's tweets alone had any effect is not known, but Bjerke's tweets were part of a wave of tweets arguing against the plans, and the total of effect of this wave of tweets had impact, among others making many media aware of the case, which then broadcasted critical articles on the forestry plans.

Published Results/Planned Publications

- International journals (includes those reported last year; project partners in **bold**)
 1. 27 May 2012 (date for online publication). Olofsson J., **Tømmervik H.** & **Callaghan T.V.** 2012. Vole and lemming activity observed from space. *Nature Climate Change* 2: 880-883, doi: 10.1038/NCLIMATE1537. ISSN: 1758-678X, EISSN: 1758-6798.
 2. 20 July 2012 (date for online publication). **Bokhorst S.**, **Bjerke J.W.**, **Tømmervik H.**, Preece C. & **Phoenix G.K.** 2012. Ecosystem response to climatic change: the importance of the cold season. *Ambio* 41 (suppl. 3): 246–255, doi: 10.1007/s13280-012-0310-5. ISSN 0044-7447 (print), 1654-7209 (online).
 3. 31 January 2013 (date for online publication). **Bjerke J.W.**, **Bokhorst S.**, **Callaghan T.V.**, **Zielke M.** & **Phoenix G.K.** Rapid photosynthetic recovery of a snow-covered feather moss and *Peltigera* lichen during sub-Arctic midwinter warming. *Plant Ecology & Diversity* 6 (3-4): 383–392. ISSN: 1755-0874 (print), 1755-1668 (online).
 4. 10 March 2013 (date for online publication). Xu L., Myneni R.B., Chapin III F.S., **Callaghan T.V.**, Pinzon J.E., Tucker C.J., Zhu Z., Bi J., Ciais P., **Tømmervik H.**, Euskirchen E.S., Forbes B.C., Piao S.L., Anderson B.T., Ganguly S., Nemani R.R., Goetz S.J., Beck P.S.A., Bunn A.G., Cao C. & Stroeve J.C. 2013. Temperature and vegetation seasonality diminishment over northern lands. *Nature Climate Change* 3: 581–586. ISSN: 1758-678X, EISSN: 1758-6798.
 5. 8 July 2013 (date for online publication). **Callaghan T.V.**, Jonasson C., Thierfelder T., Zhenlin Y., Hedenås H., Johansson M., Molau U., Van Bogaert R., Michelsen A., Olofsson J., Gwynn-Jones D., **Bokhorst S.**, **Phoenix G.K.**, **Bjerke J.W.**, **Tømmervik H.**, Christensen T.R., Hanna E., Koller E.K. & Sloan V.L. Ecosystem change and stability over multiple decades in the Swedish sub-Arctic: complex processes and multiple drivers. *Philosophical Transactions of the Royal Society, B, Biological Sciences* 368: 20120488. ISSN: 1471-2970.
- Popularized reports and newspaper feature stories (includes those reported last year, project partners in **bold**)
 1. **Bokhorst S.** 2012. Extreme winter warming harms Arctic plant growth. *Science for Environment Policy* 31: 8. In thematic issue on Arctic science, 31 April 2012. European Commission DG Environment News Alert Service. Available online: <http://ec.europa.eu/environment/integration/research/newsalert/pdf/31si.pdf>
 2. **Jørgensen M.** 2012. Overvintring under klima i endring. *Vårnnavisa* 2012, p. 7. Utgiver: Norsk landbruksrådgivning i Nord-Norge. <http://nordnorge.lr.no/vaaronnvisa/13265/>. ISSN: 1504-5706.
 3. **Riseth J.Å.**, Labba N. & **Tømmervik H.** 2012. Samisk tradisjonskunnskap om snø og is – en veiviser i klimaforskningen. *Ottar* 292: 28–34. ISSN 0030-6703.
 4. **Callaghan T.V.**, The Arctic: an indicator of the planet's health. *Tomsk State University Journal of Biology* 17: 142–147. ISSN 1998-8591.
 5. **Jørgensen M.** 2013. Nordlig landbruk krever nordlig forskning. Newspaper feature story. *Nordlys*, 26.8.2013, p. 3.
 6. **Malnes E.** 2013. Satellitter gjør skituren tryggere. Newspaper feature story. *Nordlys*, 27.9.2013, s. 3.
 7. Bevanger K., Hofgaard A., Finstad A. G., Eide N. E., Ødegaard F., **Bjerke J. W.** 2013. Naturen og klimaet. Newspaper feature story. *Adresseavisa*, 2.11.2013, p. 23, part 2. Also published online:

A bit more than halfway through the project, we have 5 international publications, as shown above. We are working on a number of manuscripts intended for international publications and expect to have several new additions to the list within a few months' time.

Communicated Results

- Presentations on news websites, conferences and to stakeholders, organizations, etc. (includes those reported last year)
1. et eksempel på ekstremvær. Lansering av Framsenterets forskningssamarbeid: Klimaeffekter på terrestre økosystemer, landskap, samfunn og urfolk, 16 December 2011, University of Tromsø. Talk.
 2. Callaghan T.V. 2011: The Arctic Environment: rapid changes and their multiple consequences. Lansering av Framsenterets forskningssamarbeid: Klimaeffekter på terrestre økosystemer, landskap, samfunn og urfolk, 16 December 2011, University of Tromsø. Talk.
 3. Jørgensen M. 2012: Hvilke utfordringer kan klima i endring gi oss? Møte Nordnorsk landbruksråd, Bodø, 21 February 2012. Talk.
 4. Jørgensen M. 2012: Overvintringsproblematikk – hva er viktig for at engplantene skal overleve vinteren? Agronomi i nord, seminar by Bioforsk, Tine and Norsk Landbruksrådgivning, Haraldvollan, Målselv, 27 March 2012. Talk.
 5. Bjerke J.W. 2012: Fram Centre: Effects of climate change on terrestrial ecosystems, landscapes, society and indigenous peoples. The Barents Euro-Arctic Council – Action plan on climate change in the Barents Regions. Workshop, Losby Gods, Lørenskog, 20 March 2012. Talk.
 6. Malnes E., Johansson C., Tømmervik H., Riseth J.Å. & Johnsen H. 2012. Monitoring the effect of extreme winter warming events on snow-covered reindeer pastures using satellite remote sensing data. IGS -International Symposium on Seasonal Snow and Ice, Lahti, Finland, 28 May 2012. Talk by Malnes.
 7. Bokhorst S. 2012. Ecosystem response to climatic change: the importance of the cold season. Symposium to celebrate Terry V. Callaghan's work. Lund, Sweden, 14 August 2012.
 8. Callaghan T.V. 2012. Popular science talk for the Cheadle Hulme Probus Club, UK. 11. January 2012,
 9. Callaghan T.V. 2012. Popular science talk for the Audlem Probus Club, UK. 23 February 2012
 10. Callaghan T.V. 2012. Popular science talk for the Culcheth Probus Club, UK. 14 March 2012.
 11. Callaghan T.V. 2012. IASC TWG, IASC Council, ASSW, IPY numerous presentations, side meetings (ABC), poster and EU and Arctic Council booths. Montreal, Canada, 15-27 April 2012.
 12. Callaghan T.V. 2012. Presentation for the European Science Foundation. Dublin, Ireland. 11-15 July 2012.
 13. Callaghan T.V. 2012. Popular science talk for the Knutsford Probus Club, UK. 9 August 2012.
 14. Bjerke J.W. 2012. EWVA. Møte i det terrestre flaggskipet. Tromsø, 7 December 2012.
 15. Callaghan T.V. 2013. Rapid Climate change in the Arctic. The EU ExpeER Executive Committee meeting. Firenze, Italia, 4 February 2013.
 16. [Forskning.no](http://www.forskning.no), 14.3.13: Under isen venter våren. Video report made by Bioforsk's public outreach expert Jon Schärer in co-operation with interviewee Marit Jørgensen, also from Bioforsk. <http://www.forskning.no/artikler/2013/mars/350746>
 17. [Bioforsk.no](http://www.bioforsk.no), 11.3.13: Under isen venter våren. Video report made by Bioforsk's public outreach expert Jon Schärer in co-operation with interviewee Marit Jørgensen, also from Bioforsk. http://www.bioforsk.no/ikbViewer/page/forside/nyhet?p_document_id=102675&p_dimension_id=15074
 18. [Callaghan T.V.](http://www.callaghan.org) 2013. Keynote address – The rapidly changing Arctic. Geographical Association Annual Conference and Exhibition "Looking to the future". University of Derby, UK, 6 April 2013.
 19. Callaghan T.V. 2013. Arctic thaw: what will it mean for Nature in the North? Understanding North, conference. Umeå University, Sweden, 25 April 2013.
 20. [Forskning.no](http://www.forskning.no) 6.5.2013: Ekstremvær stresser naturen i nord. Video report made by Bioforsk's public outreach expert Jon Schärer in co-operation with interviewees Marit Jørgensen (Bioforsk) and Jarle W. Bjerke (NINA). <http://www.forskning.no/artikler/2013/mai/355715>
 21. [NINA](http://www.nina.no) 6.5.2013: Ekstremvær stresser naturen i nord. Video report made by Bioforsk's public outreach expert Jon Schärer in co-operation with interviewees Marit Jørgensen (Bioforsk) and Jarle W. Bjerke (NINA). <http://www.nina.no/Aktuelt/Artikkel/tabid/945/ArticleId/2134/Ekstremvaer-stresser-naturen-i-nord.aspx>
 22. [Bioforsk](http://www.bioforsk.no) 6.5.2013: Ekstremvær stresser naturen i nord. Video report made by Bioforsk's public outreach expert Jon Schärer in co-operation with interviewees Marit Jørgensen (Bioforsk) and Jarle W. Bjerke (NINA). http://www.bioforsk.no/ikbViewer/page/forside/nyhet?p_document_id=103256&p_dimension_id=15074
 23. [Fram Centre](http://www.framsenteret.no) 6.5.2013. Ekstremvær stresser naturen i nord. Video report made by Bioforsk's public outreach expert Jon Schärer in co-operation with interviewees Marit Jørgensen (Bioforsk) and Jarle W. Bjerke (NINA). <http://www.framsenteret.no/ekstremvaer-stresser-naturen-i-nord.5207065-141503.html>
 24. [Vimeo.com](http://www.vimeo.com) 6.5.2013: Ekstremvær stresser naturen i nord. Video report made by Bioforsk's public outreach expert Jon Schärer in co-operation with interviewees Marit Jørgensen (Bioforsk) and Jarle W. Bjerke (NINA). <http://vimeo.com/65256340>
 25. [Callaghan T.V.](http://www.callaghan.org) 2013. The rapidly changing Arctic. A changing world: redrawing the map. Presentation for Kong Carl XVI Gustaf et al. Stockholm Castle, Stockholm, ca. 20 May 2013.
 26. Callaghan T.V. 2013. Popular science talk on climate change in the Arctic. Prestbury, Cheshire, UK, June 2013.
 27. Callaghan T.V. 2013. Popular science talk on climate change in the Arctic. Teachers Association, London, June 2013.
 28. Callaghan T.V. 2013. The rapidly changing Arctic. Second International Summer School for Students and Young Scientists. Tomsk State University, Tomsk, Russia, ca. 4 July 2013.
 29. Bjerke J.W. 2013. Endret vinterklima i nordområdene. Klimascenario 2100 - blir vi berørt av klimaendringer i nord? Hva gjør vi for å møte utfordringene? Seminar by Northern Network on Climate Change in co-operation with the Fram Centre. Tromsø, 3 September 2013.
 30. Tømmervik H. 2013. Vår og høst reduseres, og nord nærmer seg sør klimamessig. Klimascenario 2100 - blir vi berørt av klimaendringer i nord? Hva gjør vi for å møte utfordringene? Seminar by Northern Network on Climate Change in co-operation

- with the Fram Centre. Tromsø, 3 September 2013.
31. Riseth J.Å. 2013. Reindrift. Klimascenario 2100 - blir vi berørt av klimaendringer i nord? Hva gjør vi for å møte utfordringene? Seminar by Northern Network on Climate Change in co-operation with the Fram Centre. Tromsø, 3 September 2013.
 32. Jørgensen M. 2013. Klimaendringene – konsekvenser for landbruk i nord. Klimascenario 2100 - blir vi berørt av klimaendringer i nord? Hva gjør vi for å møte utfordringene? Seminar by Northern Network on Climate Change in co-operation with the Fram Centre. Tromsø, 3 September 2013.
 33. Callaghan T.V. 2013. Popular science talk on climate change in the Arctic. Goosetrey, Cheshire, UK, September 2013.
 34. Callaghan T.V. 2013. Popular science talk on climate change in the Arctic. Transition Buxton, Derbyshire, UK, September 2013.
 35. Callaghan T.V. 2013. Popular science talk on climate change in the Arctic. Bramhall, Cheshire, UK, September 2013.
 36. Bjerke J.W. 2013. Pågående og mulige framtidige samarbeidsprosjekter på klima og økologi med Bioforsk. Årsmøte for fagområde for grovfôr og kulturlandskap, Bioforsk. Holt, Tromsø, 16 September 2013. Talk.
 37. Bjerke J.W. 2013. Vinteren er fortsatt lengre enn sommeren. Official opening ceremony for the new NINA house, Trondheim, 29 October. Causerie.
 38. Ims R. A. 2013. Det terrestre flaggskipet og arktiske økosystemtjenester. Framdagen 2013, Fram Centre, Tromsø, 8 November 2013. [Note: Ims is not partner on this project. However, as leader of the terrestrial flagship, Ims gave a presentation of the flag ship projects, including main results from EWVA, provided by Bjerke to Ims before the meeting.]
 39. Media features (Includes those reported last year; for newspaper feature stories written by project partners, see above)
 40. Yr.no (<http://www.yr.no/nyheter/1.8137529>) 22.5.12: *Ekstremvær om vinteren under lupen*. Journalist: Kamilla Pedersen.
 41. Umeå universitet (<http://www.teknat.umu.se/pressinformation/nyhetsvisning/spar-av-sork-och-lammel-syns-fran-satelliter.cid190586>) 28.5.12: *Spår av sork och lämmel syns från satelliter*. Journalist: Ingrid Söderbergh.
 42. Forskning.no (<http://www.forskning.no/artikler/2012/mai/322946>) 29.5.12: *Lite lemen lager stort oppstyr*. Journalist: Helge M. Markusson.
 43. Framsenteret (<http://www.framsenteret.no/liten-lemen-lager-stort-oppstyr.5058768-141503.html>) 29.5.12: *Liten lemen lager stort oppstyr*. Journalist: Helge M. Markusson. (Article longer than that at forskning.no and with other illustrations).
 44. Adressa.no (<http://m.adressa.no/?name=adressany&i=10973/1/0&artId=125830>) 29.5.2012: *Lemenår kan ses fra verdensrommet*. Journalist: Camilla Kilnes.
 45. Dagens Nyheter (<http://www.dn.se/nyheter/sverige/sorkspar-syns-fran-rymden>) 28.5.2012: *Sorkspår syns från rymden*. Journalist: unknown.
 46. Sveriges Radio (<http://sverigesradio.se/sida/artikel.aspx?programid=109&artikel=5125859>) 28.5.2012: *Lämlars arbete syns från rymden*. Journalist: unknown.
 47. NRK Nordnytt (http://www.nrk.no/nyheter/distrikt/troms_og_finnmark/1.8162529) 29.5.2012: *Denne hissige krabaten satelittovervåkes fra USA*. Journalist: Rune Eitan.
 48. Länstidningen Östersund (<http://ltz.se/nyheter/ostersund/1.4754381-lamlarnas-syns-fran-rymden>) 30.5.2012: *Lämlarnas syns från rymden*. Journalist: Catarina Montell.
 49. Nordlys 2.6.2012, p. 24: *Lemen herjer i naturen*. Journalist: unknown (refers to framsenteret.no as source).
 50. Fremover 2.6.2012, p. 28: *Liten lemen lager stort oppstyr*. Journalist: Helge M. Markusson.
 51. NRK Troms og Finnmark, the radio show «Nordpå», 5.6.2012, ca. 14:45: *Lemen og satellitter*. Live radio interview with Hans Tømmervik.
 52. ScienceNordic (<http://scienordic.com/little-lemmings-are-monitored-space>) 8.6.2012: *Little lemmings are monitored from space*. Journalist: Helge M. Markusson.
 53. Nordlys 2.8.2012, p. 8: *Trodde du at klimaendringer vil gi oss varmere sommer? Glem det...* . Journalist: Dima Emelianov. Interview with Jarle W. Bjerke.
 54. Earth Emphasis 15.10.2012: Key research article: Vegetation recovery following extreme winter warming events in the sub-Arctic estimated using NDVI from remote sensing and handheld passive proximal sensors. <http://earthemphasis.com/key-research-articles/vegetation-recovery-following-extreme-winter-warming-events-in-the-sub-arctic-estimated-using-ndvi-from-remote-sensing-and-handheld-passive-proximal-sensors/>
 55. VG 31.10.12, pp. 26-27: *Slik vil været påvirke oss*. Journalist: Siri Eggen. Commentaries from Jarle W. Bjerke and other experts on climate change effects.
 56. Framsenteret 19.11.2012 (<http://www.framsenteret.no/bjerke-og-rikardsen-vant-framsenterprisene.5128516-141503.html>) *Bjerke og Rikardsen vant Framsenterprisene*. Journalist: Helge M. Markusson.
 57. iTromsø 29.11.12, s. 14: Vant pris. Journalist: Ida Ramberg.
 58. University of Tromsø 27.11.12 (http://uit.no/nyheter/artikkel?p_document_id=321468&p_dim=88209): *Bjerke og Rikardsen vant Framsenterprisene*. Journalist: Helge Markusson.
 59. Nordlys 1.12.12, p. 24: Vant forskningspris. Journalist: Not stated.
 60. Fram Forum 2013, p. 73: Bjerke and Rikardsen won the Fram Centre awards. Reporters: Jo J. Aarset & Helge M. Markusson. ISSN: 1893-5532 (print), 8193-5540 (online).
 61. Fram Forum 2013, p. 76: Projects in the Fram Centre Flagships for 2012 – Effects of climate change on terrestrial ecosystems, landscapes, society and indigenous peoples (Terrestrial). ISSN: 1893-5532 (print), 8193-5540 (online).
 62. A series of media reports related to the article in *Nature Climate Change* on which project partners Callaghan and Tømmervik are co-authors. One of the co-authors have summarized all the media reports on a web page, see : <http://cliveg.bu.edu/greeningearth/ssnltydim/ssnlty-dim.html> for a list updated in April 2013. It shows that more than 263.000 media features were found by Google. Norwegian media reports related to the results in this article are listed below.
 63. Aftenposten 7.4.13, front page + pp. 4-5: *Vekstsesonen har økt med én måned* (front page headline). *Vår og høst blir borte* (main article headline, p. 4). Journalist: Ole Mathismoen. Also published online: <http://www.aftenposten.no/nyheter/iriks/Var-og-host-blir-borte-7166753.html>
 64. Adressa.no 7.4.13: *Vår og høst kan forsvinne*. Journalist: Ole Mathismoen. <http://www.adressa.no/nyheter/innenriks/article7359135.ece>
 65. Aftenbladet.no 7.4.13. *Vår og høst kan forsvinne*.
 66. NINA 8.4.13: *Nord nærmer seg sør klimamessig*. Journalist: Helge M. Markusson. <http://www.nina.no/Aktuelt/Artikkel/tabid/945/ArticleId/2124/Nord-naermer-seg-sor-klimamessig.aspx>

67. [Fram Centre 8.4.13: Nord nærmer seg sør klimamessig](http://www.framsenteret.no/nord-naermer-seg-soer-klimatemessig.5189018-141503.html). Journalist: Helge M. Markusson. <http://www.framsenteret.no/nord-naermer-seg-soer-klimatemessig.5189018-141503.html>
68. [51 news features online, 5.4.-8.4.13: Various headline versions, e.g.: «Naturfenomen skyld i stinkende vår», «Stinkende vårlukt», «Dette er grunnen til at det lukter vondt om dagen» and «-Det lukter vondt, det lukter gris»](#). Features in, among others, *Nationen*, *Fredriksstad blad*, *Aftenposten*. Based on interviews made by NTB with Marit Jørgensen on the 2013 ground-ice phenomenon.
69. *Kungliga Vetenskapsakademien* 19.3.2013: North is becoming south, new study in *Nature Climate Change*. <http://kva.se/en/News/News-2013/North-is-becoming-south-new-study-in-Nature-Climate-Change/>
70. NRK.no 6.5. 2013: Dyrelivet og vegetasjonen i nord stresses. Journalist: Jan Riise Pedersen. http://160.68.205.250/nyheter/distrikt/troms_og_finnmark/1.11015016
71. *Barents Observer* 8.5.2013: The Arctic is pushed north. Journalist: Jonas Karlsbakk. <http://barentsobserver.com/en/nature/2013/05/arctic-pushed-north-08-05>
72. NRK P1 Nordpå 14.5.2013: Ekstremvær stresser naturen i nord. Live radio interview with Jarle W. Bjerke. Reporter: Egil Jens Pettersen. 6 minutes long. Available at <http://radio.nrk.no/serie/distriktsprogram-troms-og-finnmark/dktr02004713/14-05-2013> (from ca. 43:15).
73. *Stavanger Aftenblad*, 28.5.2013: Store frostskeer på blåbærlyng og einer. Journalist: Odd Pihlstrøm. <http://www.aftenbladet.no/nyheter/lokalt/jaeren/Store-frostskeer-pa-blabarlyng-og-einer-3185957.html>
74. *Stavanger Aftenblad*, 29.5.2013, front page + pp. 4-5: Frostskeer gir dårlig bærår. Journalist: Odd Pihlstrøm.
75. *Nordlys*, 8.6.2013, p. 9: Store avlinger. Journalist: Stein Wilhelmsen.
76. Swedish Polar Research Secretariat Yearbook 2012 (vol. 12, June 2013), p. 48: Forskningsprosjekt vid Abisko naturvetenskapliga station 2012.
77. *Storm.no*, 18.8.2013: De norske årstidene er i ferd med å forsvinne. Journalist: Ronald Toppe. <http://www.storm.no/nyheter/de-norske-aarstidene-er-i-ferd-med-aa-forsvinne-4006860.html>

Interdisciplinary Cooperation

EWWA is a truly multidisciplinary project integrating knowledge from experts in ecology, climatology, geosciences, earth observation, modelling, physiology and social sciences. The multidisciplinary approach has so far run smoothly. Much effort has been made to bring the experts of the various fields together and make them talk the same language. This is vital for any multidisciplinary project, so that it does not develop into a project of several parallel lanes, one for each discipline, without overlapping nodes. All partners of the consortium have previous experience with multidisciplinary approaches and this eases the challenges of getting the experts to continuously think with multidisciplinaryity in mind. This project would not have been possible without integrating experts of several fields.

Budget in accordance to results

EWWA has benefitted from the Fram Centre funding in several ways. Firstly, it has made it possible for the Fram Centre personnel to allocate more working hours to the project. This has secured that the stated tasks have been undertaken satisfactorily, and that the milestones have been achieved on schedule. Moreover, it has made it possible to expand our public outreach activity. As our lists above show, we have had very much contact with the media, including the production of two video reports which have received much interest after being broadcasted at forskning.no and several other websites. These video reports would not have been made without the Fram Centre funding. The additional funding has also made it possible for the project partners to be much more active in national and international media, which can be seen from the many interviews we have given and news reports we have contributed to. This includes three newspaper feature stories (“kronikker” in Norwegian). We have also presented project results at several occasions to relevant persons in the political, management and bureaucracy sections. Without additional funding this would not have been possible. The increased time use also makes it possible to pursue some of the project themes in further detail. This will lead to more valuable results relevant for the society and management, and will also result in more scientific publications arising from this project. For example, during 2013, the additional Fram Centre funding has made it possible for us to follow up recent extreme events in much more detail than our ambition would have been without the funding by allocating more time to fine-resolution time series analyses using remote sensing imagery, and sub-daily meteorological analyses of observed short-lasting, but high-impact events like frost night events occurring during the growing seasons. Frost outside the cold seasons is a poorly studied phenomenon which we now can shed new light on. Field work done in 2012, made possible through last year’s Fram Centre funding (see last year’s report), gave valuable results on biological responses to various disturbance events, and these results now is a key component in a manuscript with a multidisciplinary approach that soon will be ready for submission.

NINA’s projects on winter climate and air pollution also led to an invitation from UK universities to get involved in a large doctoral training partnership (DTP). This partnership network recently received major funding from the Natural Environment Research Council (NERC; <http://www.sheffield.ac.uk/news/nr/funding-will-keep-uk-at-the-forefront-of-environmental-science-research-1.324702>), and it is likely that Bjerke and Tømmervik, and perhaps other NINA scientists, will co-supervise PhD students enrolled at UK universities in the coming years, and these students will then have projects closely related to the themes in WINNIT and WICLAP. NINA’s involvement in this DTP can therefore also be seen as a result of the Fram Centre funding to Bjerke and co-workers since 2011.

The project “WICLAP” is another outcome of the Fram Centre funding to Bjerke and co-workers; see under Chapter 12 below for more information.

If Yes

The project partner NORUT is developing a monitoring system for snow cover including wet snow monitoring which could be useful for commercial sectors, especially the energy sector. The development of the system is mainly done in projects running in parallel with EWWA, but experiences achieved while performing the tasks of WP 2 of EWWA also contributes to this development process.

Conclusions

a) EWWA will still run for another 14 months. Although nearly 40 % of the project period remains, we have already gained many interesting results, and most of these are not yet published. Thus, it is still a bit premature to give a full evaluation of future research directions and perspectives. However, ideas developed partly during EWWA have given rise to two additional externally financed projects related to winter climate change. WINNIT is the first of these two, and it also received Fram Centre funding for 2013 (see separate report). The title of second project is "*Ecosystem stress from the combined effects of winter climate change and air pollution - how do the impacts differ between biomes*". It is financed by the Poland-Norway grant and will run from December 2013 to November 2016. Its acronym is WICLAP, and the Norwegian co-ordinator is Jarle W. Bjerke, who is also project leader of EWWA. This proposal was briefly described in last year's report.

Both these "spin-off" projects deal with multiple stressors; namely climate change-induced stress and pollution stress. They are therefore in line with recent science progress showing that the combined effects of multiple drivers may be quite different from effect of isolated drivers, and that multiple drivers should be analyzed and assessed in concert.

b) During the progress, we have seen the need for developing new techniques for handling long-term series of meteorological data in multilayer snow models and remote sensing data for monitoring of snow thaw events. These new techniques will be published in separate papers and be useful worldwide for cryosphere scientists working with snow and ice modelling and monitoring. A more detailed description of these techniques will be given when we have published on them in the scientific literature. This is also linked to the information given in Chapter 11 on commercial utilization; see above.