

EGU2020-12784

<https://doi.org/10.5194/egusphere-egu2020-12784>

EGU General Assembly 2020

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Positive feedback from climate warming to carbon sequestration in boreal forests

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EGU Abstract, 3-8 May, Vienna 2020

Session BG3.19

Climate change and adaptive forest management: Effects, Methods, and Objectives

Positive feedback from climate warming to carbon sequestration in boreal forests

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'Wovon man nicht sprechen kann, darüber muß man schweigen.' ("Whereof one cannot speak, thereof one must be silent."). This quote of Ludwig Wittgenstein is thought-provoking regarding beneficial effects of climate change. Logically, climate warming must provoke favorable environmental effects in some regions and over certain periods of time despite the prospects of dramatic detrimental effects of global warming on the environment in the long term. Our focus is on boreal forests in recent past.

Devastating effects of climate warming on terrestrial ecosystems have been recorded in many parts of the world. Heat waves have enhanced wildfires. In Australia alone, wildfires disturbed more than six million hectares of land in 2019-2020. Will climate warming undermine the contribution of land use management to climate change mitigation? - Most surprisingly, we report here a reverse relationship from north Europe. Climate warming has amplified the favorable impacts of land management on carbon sequestration. This is a forest-climate paradox, maybe temporary and anecdotal but persistent and firmly documented in Finland, Norway and Sweden since 1990.

Springtime is the most interesting season for forest biota in north Europe. During spring in north Europe, soil is rich in moisture from the snow melt. Days are long as of the beginning of April. Cloudy weather is unusual in the springtime. When spring comes early, there is plenty of solar radiation and water available for photosynthesis and growth. Warm spring evokes an early bud

burst. Conversely, cold spring delays the onset of the growing season. April and May temperatures were exceptionally high during the period 1990-2013 (Figs. 1a and 1b) . Similar patterns of climate warming were observed in Norway and Sweden.

Figure 1a. Average temperature in Finland in April during 1847-2013 (degrees centigrade).

Figure 1b. Average temperature in Finland in May during 1847-2013 (degrees centigrade). Especially during 1990-2019 the growing seasons in north Europe turned out to be long. The Net Primary Production and forest carbon sink improved. Forest increment in north Europe approximately doubled from 1970 to 2010 responding to multiple drivers . A combination of successful forest management and environmental change created an interesting paradox promoting forest ecosystem services. Carbon sink improved concomitantly with increasing harvests for the forest industries, an important economic sector in the region. In so far, climate warming specifically in north Europe has contributed significantly to the evolution and persistence of the carbon sink and to fossil fuel substitution. Future research is needed to monitor this feedback from climate warming to carbon sequestration.