POLICY BRIEF

FOREST CARBON SINKS AND VULNERABILITIES UNDER CLIMATE CHANGE – WHAT WE KNOW ABOUT FINNISH FORESTS?

Climforisk EU Life+ project (2011-2014, ENV/FI/000571) aimed at generating more comprehensive picture about future of Finnish forests. The project pulled together forest related data sources, climate scenarios and developed methodologies to estimate carbon sinks and growth of Finnish forests in the future. The project further assessed the possibilities of estimating changes of damage vulnerability of forests based on existing information. This policy brief lists main findings of the project.

Finnish forests will continue being a carbon sink

Changing climate benefits photosynthesis, vegetation biomass accumulation, and stem-wood growth in Finland

- *Average changes in photosynthesis, biomass accumulation, and stem-wood growth of forests in Finland were clearly positive in all impact model simulations, which were run with combinations of three climate scenarios and eight climate models.*
- *In the long term, total biomass carbon stocks increase in Finland, but part of the positive increases in vegetation carbon stock are offset by increasing soil carbon emissions. In the short terms, and periods of few decades, harvest regime will continue to be the most important factor influencing carbon sink in forests.*
- *Contrasts between poor and productive sites in stem wood growth will increase in future because high productivity sites have more growth resources to support CO_2 fertilisation. This in turn may influence the relative profitability of forestry at given sites.*
- *Insect pests overwintering in the egg stage are most probable to benefit from warming climate. Large scale outbreaks are rare, but when they occur, they can temporarily have strong effects on forest carbon emissions and nutrient fluxes.*
- *Warming winters also increase the problems from certain pathogens like root rot, and this, in combination with longer frost-free periods increases wind damages. These, in turn, increase the risks of bark beetle outbreaks.*
- *Increasing temperatures speed up the development of pest insects. This means earlier pest development and possibly more generations. Salvage and sanitation cuttings should be done in time to prevent further damages. We launched portal to monitor spring development of serious pest insects that facilitates the protective actions of forests by forest managers and owners.*

Positive but uncertain

- *In spite of the predicted positive changes of forest productivity, the uncertainties of future carbon balance and growth estimates are large, and increase towards future. Uncertainties stem from many sources:*
  - *There is uncertainty about sosio-economic and technical development (scenario uncertainty).*
  - *Predictions of future climate vary largely by climate model.*
  - *Water balance of forests is uncertain due to uncertain rainfall estimates and uncertainties in tree water use under elevated CO2.*
  - *Long-term growth effects of CO_2 fertilization on trees are uncertain, largely due to uncertainties associated with nitrogen availability.*
  - *Changes of soil carbon stocks are uncertain and depend on both decomposition sensitivity and litter inputs that are oppositely affected by climate, and their responses to climate change are not accurately known. Different soil model versions produce different predictions for soil carbon sinks and sources.*
  - *Changes of productivity under climate change seem more pronounced in the north Finland than in the south Finland, but there are considerable uncertainties in spatial resolution of climate models.*
  - *Changes in damage regimes cannot be reliably quantified presently. Qualitative estimates predict increase of damage frequencies and intensities of some pests.*
  - *Climatic extremes (e.g., minimum winter temperatures) are more important for pest population dynamics than mean temperatures, but their interpolation at high resolution is challenging and needs more efforts.*
  - *ICP Forests and rolling Forest Inventory (FI) data have good potential for quantifying patterns in damage occurrence, but region-wise FIs may produce biased results.*

Anticipation of changes requires impact research

- *Proposal "accounting rules and action plans on greenhouse gas emissions and removals resulting from activities related to land use, land use change and forestry (COM(2012) 93 final)" called for mandatory reporting of greenhouse gas balances for lands under forest management. We developed tools to support this goal. We produced a tool that can be used to estimate sinks and sources of lands under forests management at high spatial resolution, so as to support regional decision making and GHG-inventories. Still, we concluded that there are large gaps of knowledge, which hamper accurate estimation of sinks at small spatial scales under climate change.*
- *Predictive tools should be further developed to allow site-specific detailed assessments of forest growth scenarios under climate change. These scenarios would be valuable for individual forest owners in Finland. Enhanced information about the effects of nutrient release from soils on growth under climate change are needed.*
- *Present soil databases do not support local level carbon sink estimation, especially in dry conditions. New LIDAR based measurements of topographical variation at 1 m resolution will open new avenues in research.*
- *Forest damages can lead to large carbon emissions within a short time period. European level forest damage data collection is needed to facilitate the construction of predictive models. Forest inventories should also collect damage information at annual level from forests.*
- *Pest and pathogens can be best controlled by timely preventive actions (salvage and sanitation cuttings to control bark beetles), which could be facilitated by developing online monitoring of pest status and near-future forecasts of pest development. Overall damage risks can be minimized by diversifying forest structure.*

With high probability, Finland will become even more suitable region for forestry than it is nowadays. Risks can be minimized by diversifying management and forest structure. But still, basic research is required to reduce uncertainties of forest growth predictions. Due to the highly complex and variable nature of pest dynamics, actions should be taken to collect coherent and pan-European long-term datasets of forest pest damages and required ancillary data, which would support predictive modelling in future.

http://www.luke.fi/projektit/climforisk

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Climate change induced drought effects on forest growth and vulnerability (Climforisk)

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