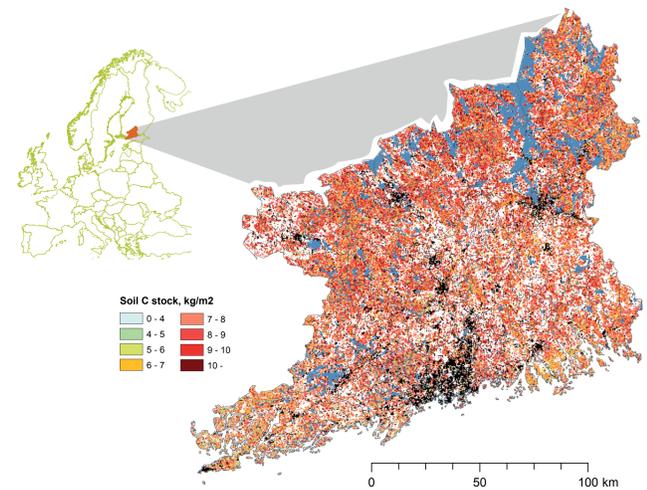


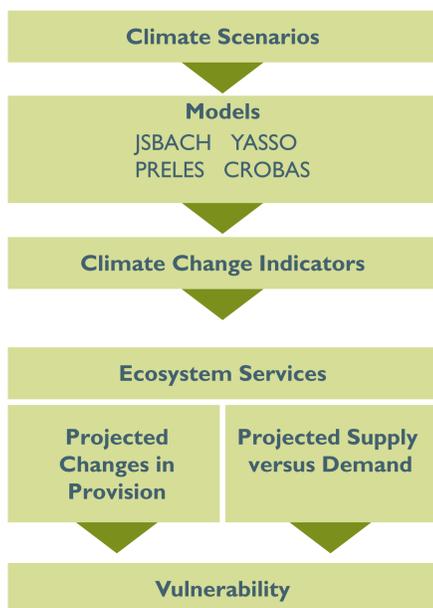
# Vulnerability to climate-induced changes in ecosystem services of boreal forests

## 1 Ecosystem services in a warming climate

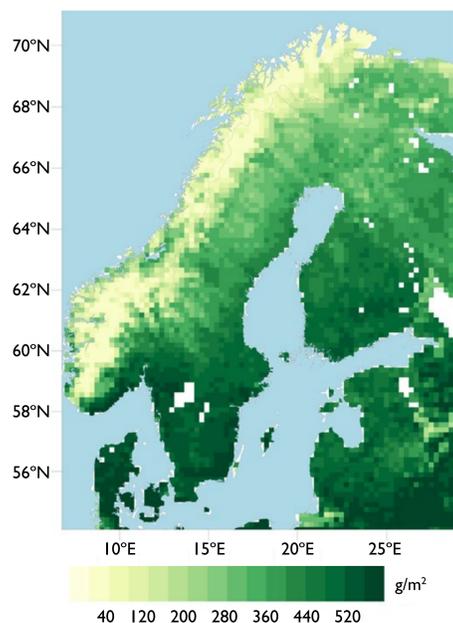
Boreal forests provide an array of ecosystem services. They regulate climate, and carbon, water and nutrient fluxes, and provide renewable raw material, food, and recreational possibilities. Rapid climate warming is projected for the boreal zone<sup>1</sup>, and observed in Finland<sup>2</sup>, which sets these services at risk. In MONIMET, we use state-of-the-art models and new monitoring methods to investigate the impacts of a warming climate on the provision of ecosystem services of boreal forests (Fig. 1). This poster presents results on carbon storage in soil and assessment of drought indices, as a preparation for assessing the vulnerability of society to climate-induced changes in ecosystem services. The risk of decreasing provision of ecosystem services depends on the sensitivity of the ecosystem as well as its exposure to climate stress. The vulnerability of society, in turn, depends on the risk of decreasing provision of a certain service in combination with society's demand for that service.



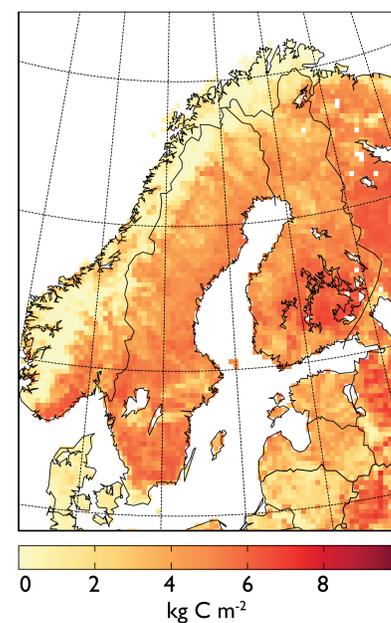
**Fig. 4.** Present day soil carbon stocks (SOC kg m<sup>-2</sup>) calculated with GIS-based tool<sup>5</sup> combining Yasso<sup>4</sup> soil model with information on forest structure.



**Fig. 1.** From Climate Scenarios to Vulnerability in MONIMET.



**Fig. 2.** Present day net primary production (NPP g m<sup>-2</sup>) calculated with land surface model JSBACH<sup>3</sup> coupled with Yasso<sup>4</sup> soil model.



**Fig. 3.** Present day soil carbon stocks (SOC kg m<sup>-2</sup>) calculated with land surface model JSBACH<sup>3</sup> coupled with Yasso<sup>4</sup> soil model.

## 2 Carbon budget

Present day net primary production (NPP, Fig. 2) and soil carbon stocks (SOC, Fig. 3) were produced with land surface model JSBACH<sup>3</sup> coupled with Yasso<sup>4</sup> soil carbon model for northern Europe. In a regionally focused analysis, the SOC (Fig. 4) for the Häme-Uusimaa region in southern Finland was calculated with a GIS-based tool<sup>5</sup>. An earlier comparison of the results of JSBACH with estimates of the semi-empirical stand-flux model PRELES, and the national forest ghg-inventory, indicated that it is realistic to upscale the results of JSBACH<sup>6</sup>. At a first inspection, also the SOC results of JSBACH (Fig. 3) are similar to those of the GIS-based method (Fig. 4), despite different approach for describing vegetation and a coarser resolution.

## 3 Drought stress

So far, drought events have been the most severe in southern Finland, uphill locations and areas with high areal proportion of exposed rock. A recent study indicated that extensive drought events causing damage to trees, can be predicted with model (PRELES) derived moisture indices<sup>7</sup>. In MONIMET, we analyzed a set of drought indicators<sup>8</sup>. Both site soil moisture observations and JSBACH simulations were used in deriving the indicator values. Soil moisture index was found the best indicator to describe the spatial extent of forest damage induced by extreme drought<sup>8</sup>.

## 4 Next steps

To assess the vulnerability we will make quantitative and qualitative estimates of the changes of supply and demand of the services. This task includes information on

- Changes in and requirements for carbon storage
- Changes in timber supply
- Risks of failing to collect timber
- Risks of insect damage
- Risks of decreasing water quality

We will look for solutions to challenges relating to

- Quantification of the demand for ecosystem services
- Differences in spatial extent and resolution of the information on future supply and demand

LIFE12 ENV/FI/000409, MONIMET (2.9.2013–1.9.2017)  
<http://monimet.fmi.fi>

Coordinator FMI, associated beneficiaries LUKE, SYKE, UHEL

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