# EU Life+ MONIMET

LIFE12 ENV/FI/000409

## Boreal forest ecosystem services under climate change

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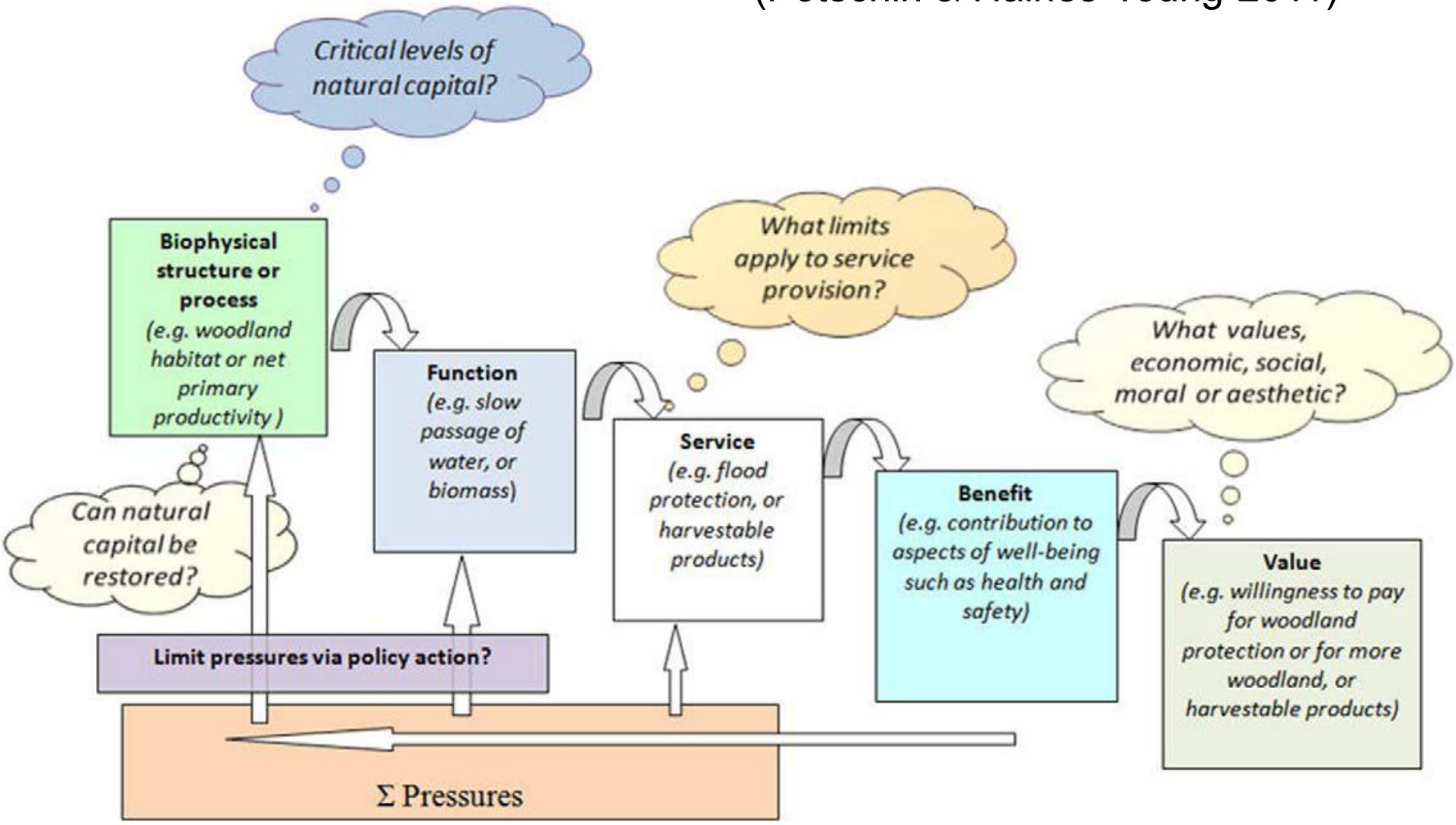
## Outline

- What are ecosystem services?
- How is the ecosystem service framework applied to Finnish forests?
- How are MONIMET climate change indicators coupled to ecosystem services?
- Three examples of projected impacts:
  - Forest growth
  - Net ecosystem exchange of CO2
  - Start of vegetation active period
- Summary of projected impacts for ecosystem services
- Vulnerability considerations

# Ecosystems service cascade model (Potschin & Haines-Young 2011)



# Common International Classification of Ecosystem Services CICES V4.3 (Haines-Young & Potschin 2013)

| Section | Division | Group |
|---|---|---|
| **Provisioning** | Nutrition | Biomass |
| | | Water |
| | Materials | Biomass, Fibre |
| | | Water |
| | Energy | Biomass-based energy sources |
| | | Mechanical energy |
| **Regulation and Maintenance** | Mediation of waste, toxics and other nuisances | Mediation by biota |
| | | Mediation by ecosystems |
| | Mediation of flows | Mass flows |
| | | Liquid flows |
| | | Gaseous/ air flows |
| | Maintenance of physical, chemical, biological conditions | Lifecycle maintenance, habitat and gene pool protection |
| | | Pest and disease control |
| | | Soil formation and composition |
| | | Water conditions |
| | | Atmospheric composition and climate regulation |
| **Cultural** | Physical and intellectual interactions with environmental settings | Physical and experiential interactions |
| | | Intellectual and representational interactions |
| | Spiritual, symbolic and other interactions with environmental settings | Spiritual and/or emblematic |
| | | Other cultural outputs |

# Application of ecosystem service framework to boreal forest

**Saastamoinen et al. (2014)**

- Applied the CICES hierarchy on the boreal forest ecosystem services in Finland
- Subdividing the service groups into 44 classes with additional subclasses.
- Include water purification, carbon sequestration, reduction of other greenhouse gases, forests and cloud formation, climate regulation and timberline forests.
- Forests maintain the hydrological cycle, regulate water flow, balance spring floods and reduce run-off

**Mononen et al. (2016)**

- Developed a framework of ecosystem service indicators for Finland that complies both with national circumstances and with international typologies such as the CICES and the cascade model.
- Indicators for 28 ecosystem services (10 provisioning, 12 regulating and maintenance and 6 cultural services),
- Set of four indicators for every stage of the cascade model (structure, function, benefit, value);
- Altogether 112 indicators.
- Covering all main ecosystem types found in Finland: forests, mires, the Baltic Sea, inland waters and farmlands

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# B7 Demonstration on ecosystem services and vulnerability

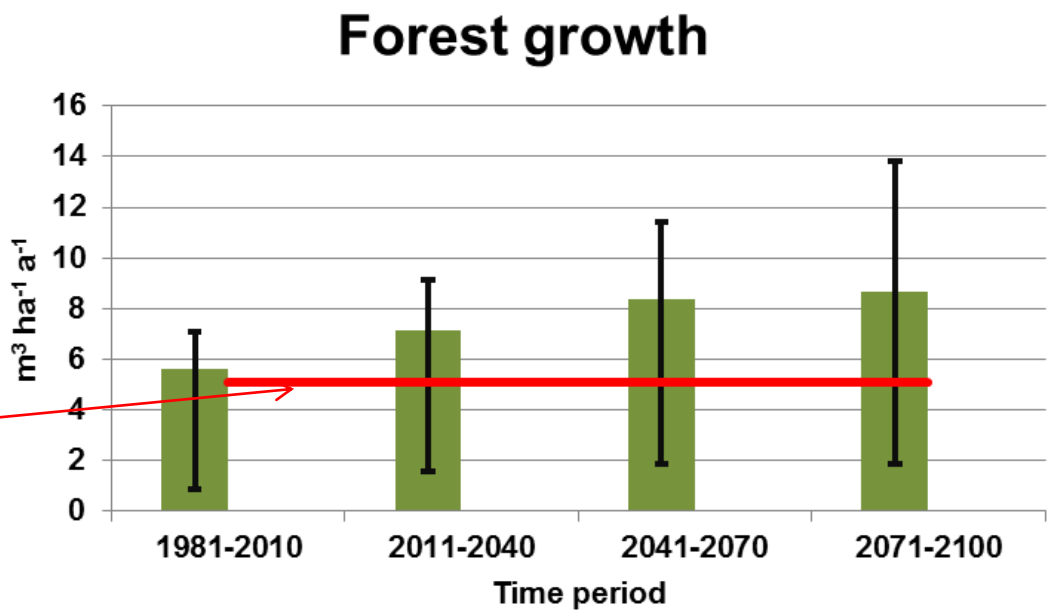
Ecosystem services linked to the climate change indicators

| Section | Class | Function | Ecosystem service (8) | Climate change indicator (16) |
|---|---|---|---|---|
| **Provisioning** | Wood | Growing stock increment | Increased biomass | GPP |
| | | | | **Stemwood growth** |
| | | | | Carbon stocks |
| **Regulating** | Maintaining habitats | Reproduction | Reproductive success and survival of species | Vegetation active period (start, end and length) |
| | Nutrient retention | Nutrient retention rate | Avoided eutrophication, Drinking water quality | N retention |
| | Climate regulation | Carbon balance | Avoided increase in radiative forcing | **NEE** |
| | | | | Sequestration rate |
| | | | | Carbon stocks |
| | | Radiation reflection | Avoided increase in radiative forcing | Albedo |
| | Water retention | Detention time | Avoided drought | Soil moisture index |
| | | | | Number of drought days |
| **Cultural** | Recreation | Snow | Opportunities for winter tourism | Number of snow cover days |
| | | | | Date of snow clearance |
| | Nature tourism | Natural events and phenology | Opportunities for nature tourism | **Start of veg. active period**<br>End of vegetat. active period<br>Length of veg. active period |

# Forest growth simulations with PREBAS

PREBAS simulations (median annual values of forest growth $m^3\ ha^{-1}$)
with 5 global climate models
and 3 levels of climate forcing
Indicate increased potential
for timber production.

Compared to:
Current average
annual forest growth
**5.1 $m^3\ ha^{-1}$**

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# NEE simulations with JSBACH

JSBACH simulations

median annual values of net ecosystem exchange of $CO_2$ NEE gC $m^{-2}$

with 4 global climate models

and 2 levels of climate forcing

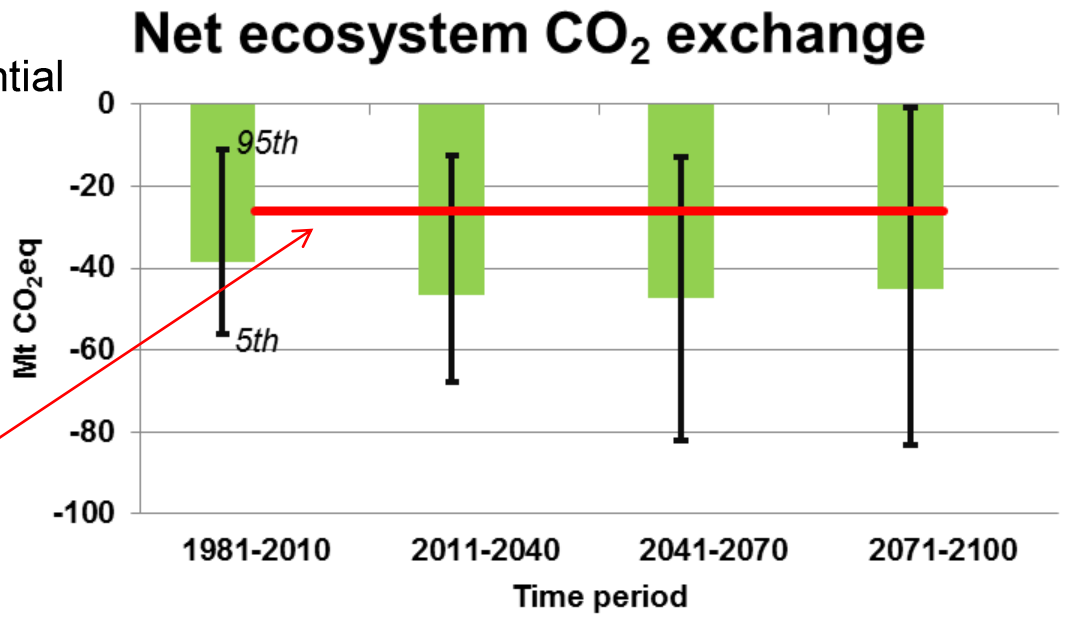
Indicate some increase in potential for carbon sequestration

Graph in unit Mton $CO_2$ eq.

Compared to:

Finland's GHG emissions of LULUCF sector 2015

**-26 mill. ton $CO_2$ eq**

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# Vegetation active period simulations with JSBACH

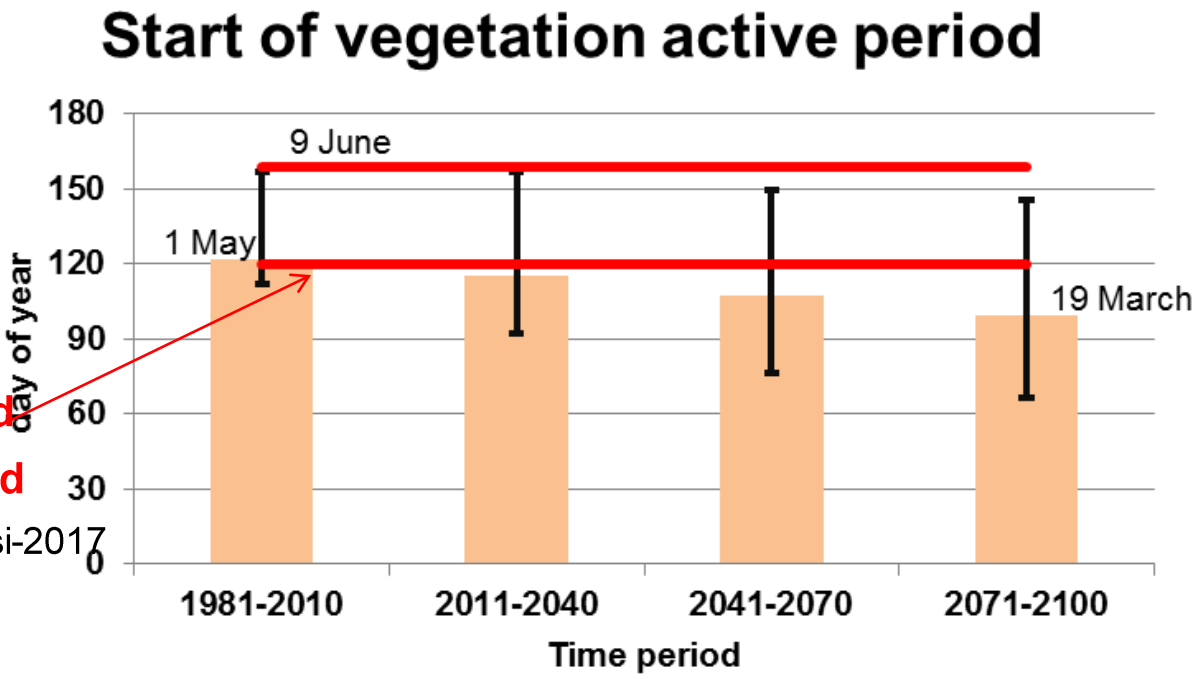
JSBACH simulations
median values of day of year for start of vegetation active period
with 4 global climate models
and 2 levels of climate forcing
Indicate earlier spring

Compared to:
Start of thermal growing season 2017

**1 May South Finland**

**9 June North Finland**

http://ilmatieteenlaitos.fi/kasvukausi-2017



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# B7 Demonstration on ecosystem services and vulnerability

Ecosystem services linked to the climate change indicators and their projected impacts

| Section | Class | Function | Ecosystem service and projected impact | Climate change indicator and projected impact |
|---|---|---|---|---|
| Provisioning | Wood | Growing stock increment | Increased biomass + | GPP + |
| | | | | Stemwood growth + |
| | | | | Carbon stocks + |
| Regulating | Maintaining habitats | Reproduction | Reproductive success and survival of species ? | Vegetation active period (start - , end and length +) |
| | Nutrient retention | Nutrient retention rate | Avoided eutrophication, + / - Drinking water quality | N retention + / - |
| | Climate regulation | Carbon balance | Avoided increase in + radiative forcing | NEE + |
| | | | | Sequestration rate + Carbon stocks + |
| | | Radiation reflection | Avoided increase in radiative forcing ? | Albedo + / - |
| | Water retention | Detention time | Avoided drought ? | Soil moisture index + / - |
| | | | | Number of drought days + |
| Cultural | Recreation | Snow | Opportunities for winter tourism - | Number of snow cover days - |
| | | | | Date of snow clearance - |
| | Nature tourism | Natural events and phenology | Opportunities for nature tourism + | Start of veg. active period - End of veg. active period + Length of veg. active period + |

# B7 Demonstration on ecosystem services and vulnerability

**Table 4.** Vulnerability of society to changes in ecosystem services linked to the climate change indicators /**Provisioning services**

| Section | Class | Function | Vulnerability | Ecosystem service | Climate change indicator |
|---|---|---|---|---|---|
| **Provisioning** | **Wood** | **Growing stock increment** | **Change in biomass relative to reference, considering future demand (business as usual and increased use of bioenergy)** | **Increased biomass** | **GPP (Gross primary production)** |
| | | | | | **Stemwood growth** |
| | | | | | **Carbon stocks** |

# B7 Demonstration on ecosystem services and vulnerability

**Table 4.** Vulnerability of society to changes in ecosystem services linked to the climate change indicators / **Regulating services**

| Section | Class | Function | Vulnerability | Ecosystem service | Climate change indicator |
|---|---|---|---|---|---|
| Regulating | Maintaining habitats | Reproduction | Change in the length of VAP to reference considering productive performance and risks of insect outbreaks | Reproductive success and survival of species | VAP length (Vegetation active period)<br>Start and end of VAP |
| | **Nutrient retention** | **Nutrient retention rate** | **Change in N retention rel. to ref. and present (and future) population** | **Avoided eutrophication, Drinking water quality** | **N retention** |
| | Climate regulation | Carbon balance | Change in NEE (and seq. rate, stocks) rel. to ref., considering mitigation targets | Avoided increase in radiative forcing | NEE (Net ecosystem exchange) |
| | | | | | Sequestration rate |
| | | | | | Carbon stocks |
| | | Radiation reflection | Change in winter/spring albedo to reference; considering risk of decreasing cooling effect | Avoided increase in radiative forcing | Albedo |
| | **Water retention** | **Detention time** | **Change in number of drought days rel. to ref., considering risks to forest growth** | **Avoided drought** | **Soil moisture index** |
| | | | | | **Number of drought days** |

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# B7 Demonstration on ecosystem services and vulnerability

**Table 4.** Vulnerability of society to changes in ecosystem services linked to the climate change indicators / **Cultural services**

| Section | Class | Function | Vulnerability | Ecosystem service | Climate change indicator |
|---|---|---|---|---|---|
| **Cultural** | **Recreation** | **Snow** | **Change in number of days and date rel. to ref. and demand (statistics on winter and Easter tourism)** | **Opportunities for winter tourism** | **Date of snow clearance** |
| | | | | | **Date of snow clearance** |
| | Nature tourism | Natural events and phenology | Change in timing of phenological events that attract people (statistics on autumn tourism) | Opportunities for nature tourism | Start of VAP |
| | | | | | End of VAP, autumn colours |

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