EU Life+ MONIMET

LIFE12 ENV/FI/000409

Tentative approaches for vulnerability assessment

- What does the warming of forests mean for society

29.9.2015

Maria Holmberg, SYKE

Boreal forests as suppliers of ecosystem services

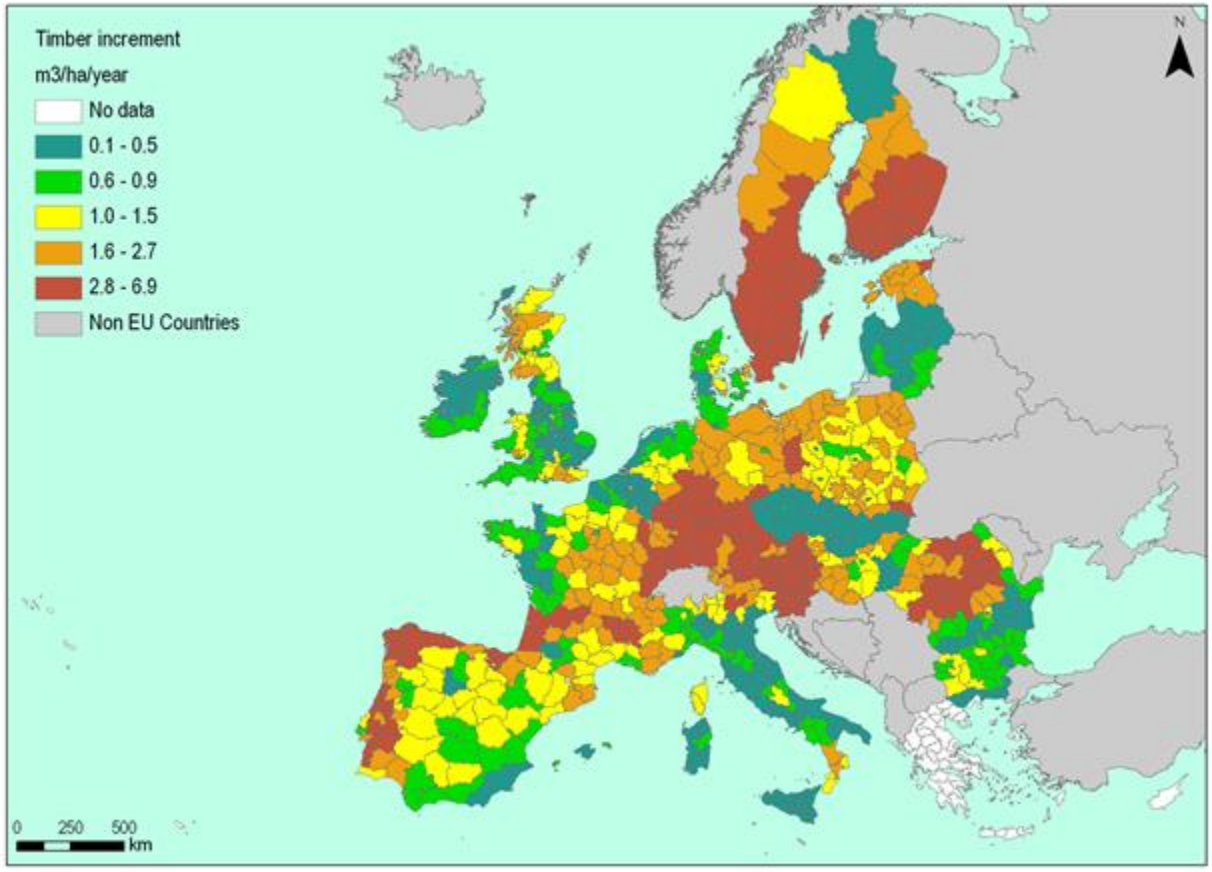
Ecosystem services are

> ”***Contributions of ecosystem structure and function – in combination with other inputs – to human well-being***” (Burkhard et al. 2012)

Boreal forests and wetlands provide a wide array of services. They have high potential of storing carbon, aid in erosion and air quality control, provide recreation and timber, and support the regulation of soil and water (e.g. Maes et al. 2011).

Provisioning services: Timber increment
(Maes et al. 2011)

Timber increment per NUTS3 statistical area. Source: European Forest Institute, EFISCEN forest inventory database (Fig. 1. Maes et al. 2011, EC JRC EUR 24750 EN – 2011 doi:10.2788/63557)

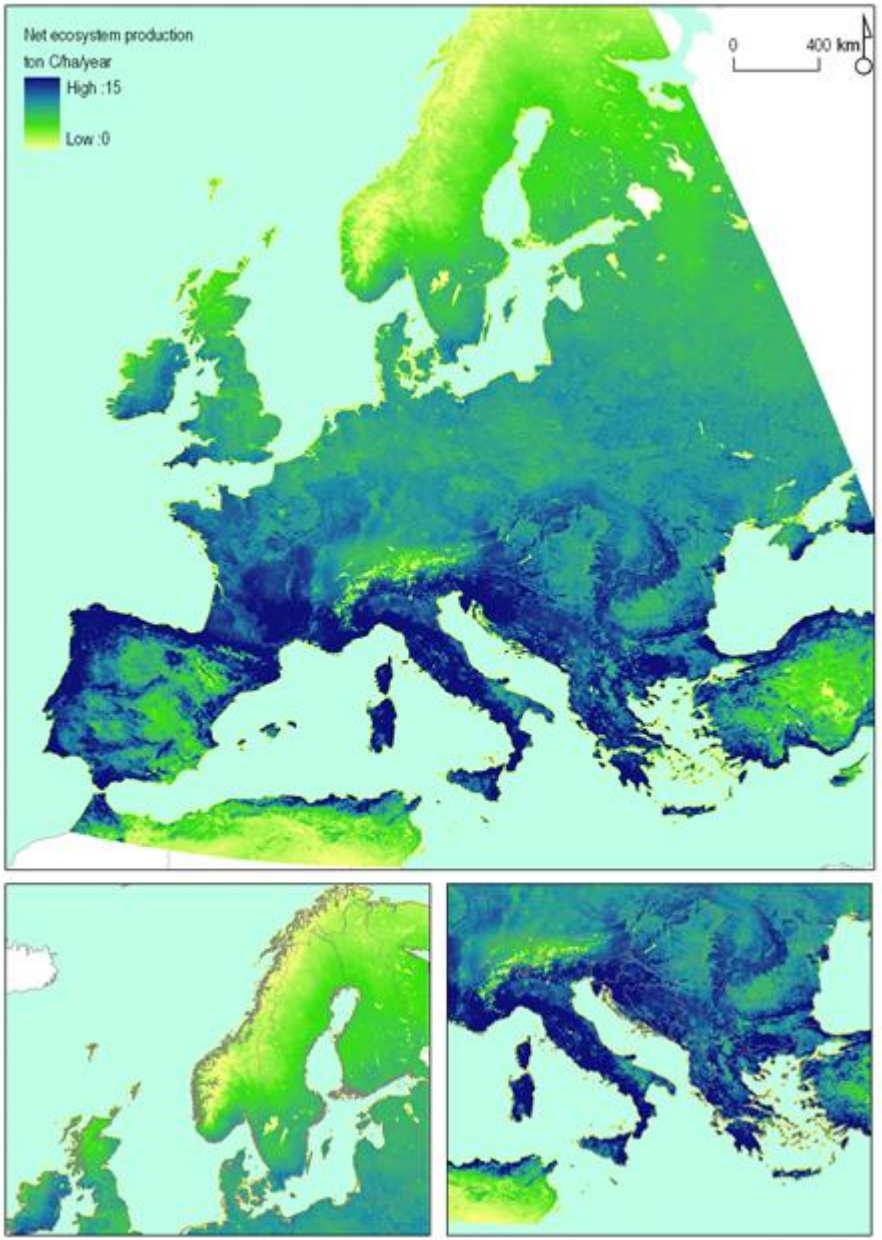


SYKE

Regulating services: Climate services by carbon sequestration

(Maes et al. 2011)

Carbon fixation approximated by net ecosystem productivity (NEP). The NEP takes into account the soil respiratory flux originating from heterotrophic decomposition of soil organic matter (quatified using the C-Fix model, from SPOT VGT S10 images, using the Normalized Difference Vegetation Index (NDVI). Resolution 1/112°. Data source: VITO (Fig. A9. Maes et al. 2011, EC JRC EUR 24750 EN – 2011 doi:10.2788/63557)



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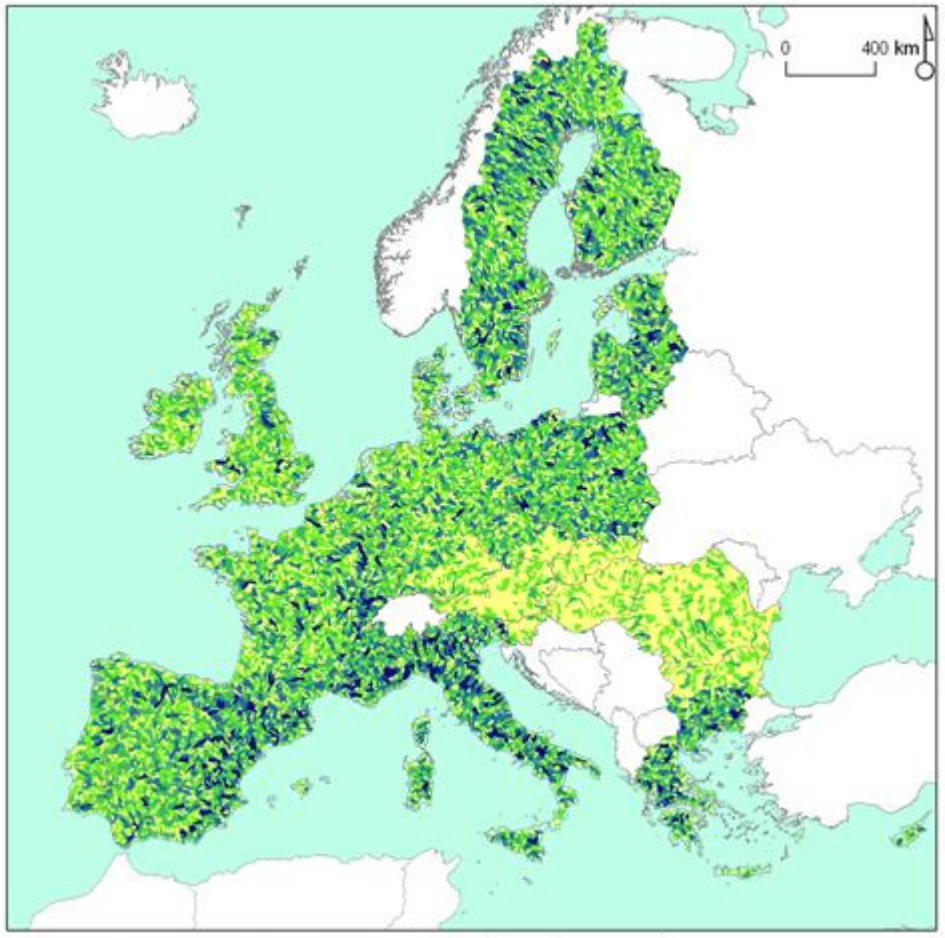
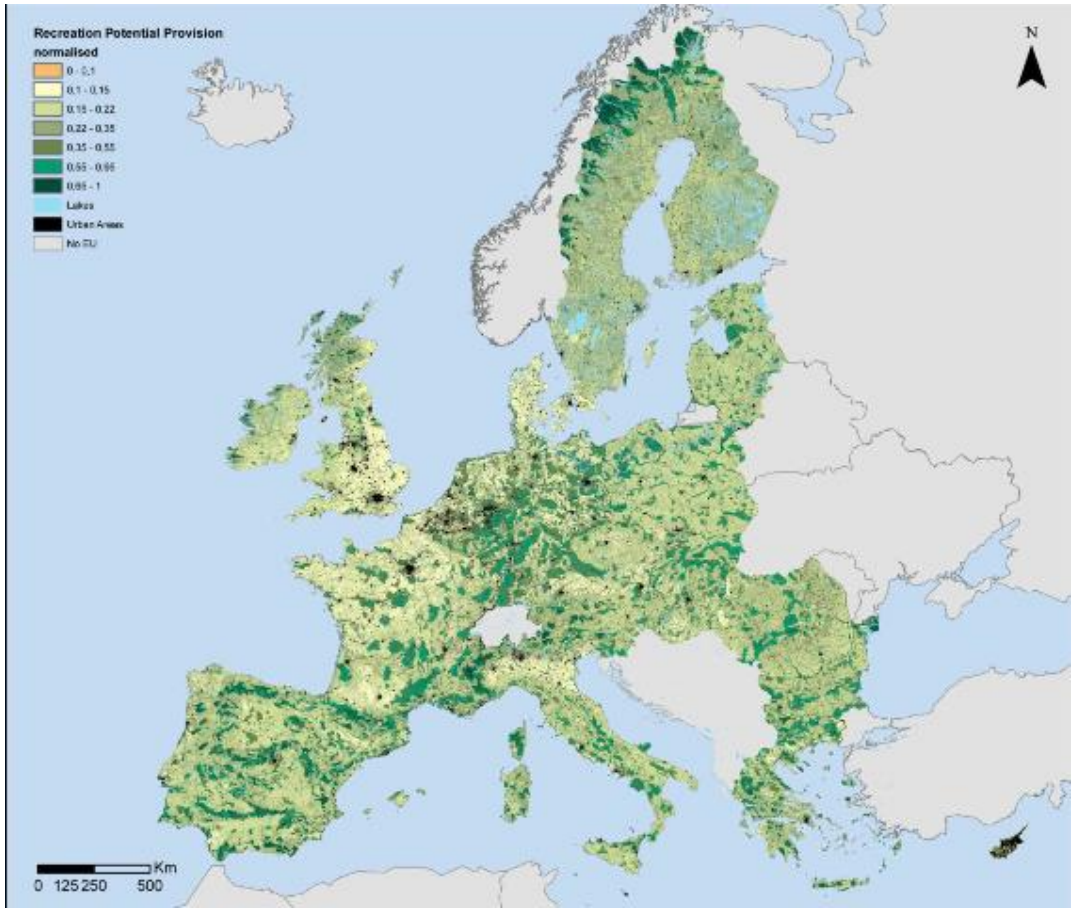
Regulating services: Nitrogen retention by rivers and streams
(Maes et al. 2011)

Nitrogen retention (%) by retention processes in rivers and large lakes. The map is based on the model GREEN (Grizetti et al. 2005) which assesses at European scale the fate and transport of nitrogen. Europe is divided into over 30000 subcatchments (10 km resolution) (Fig. A6. Maes et al. 2011, EC JRC EUR 24750 EN – 2011 doi:10.2788/63557)

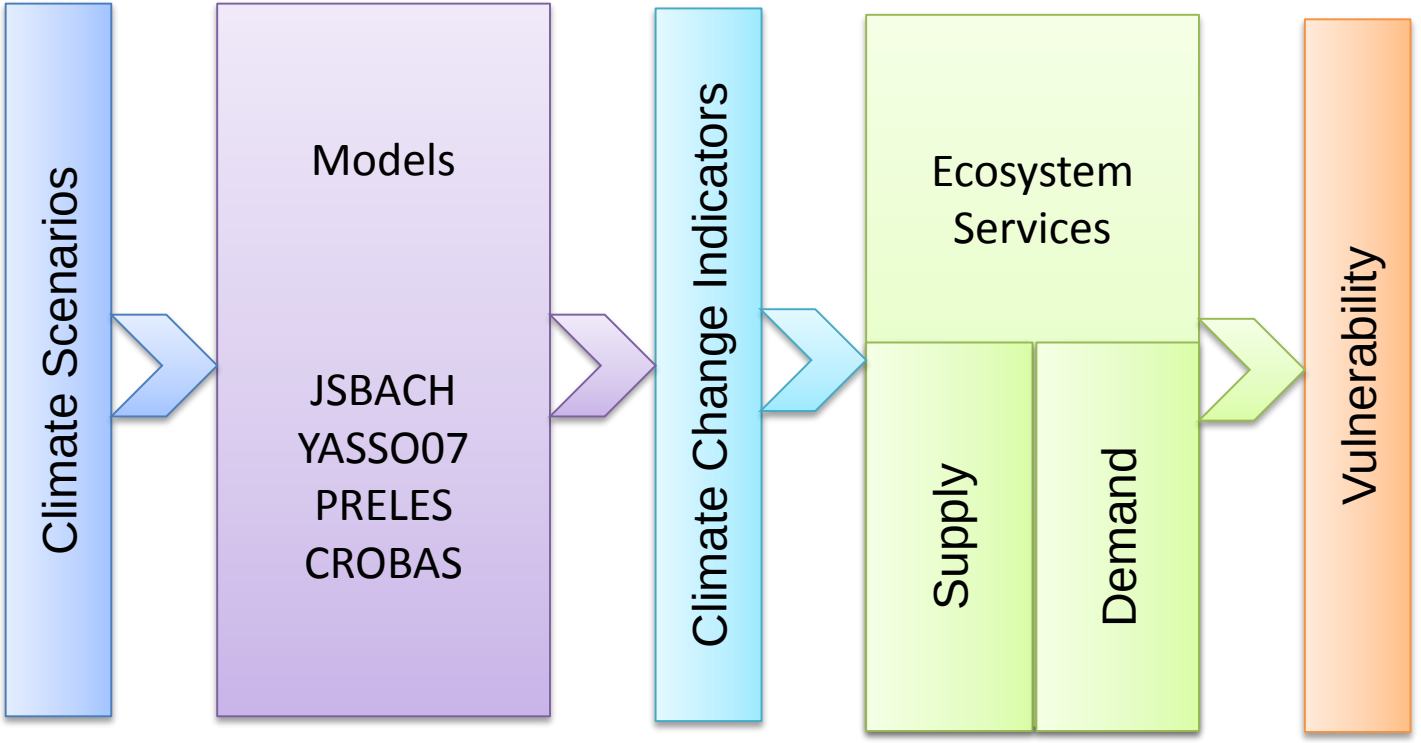


Cultural services: Recreation potential index
(Maes et al. 2011)

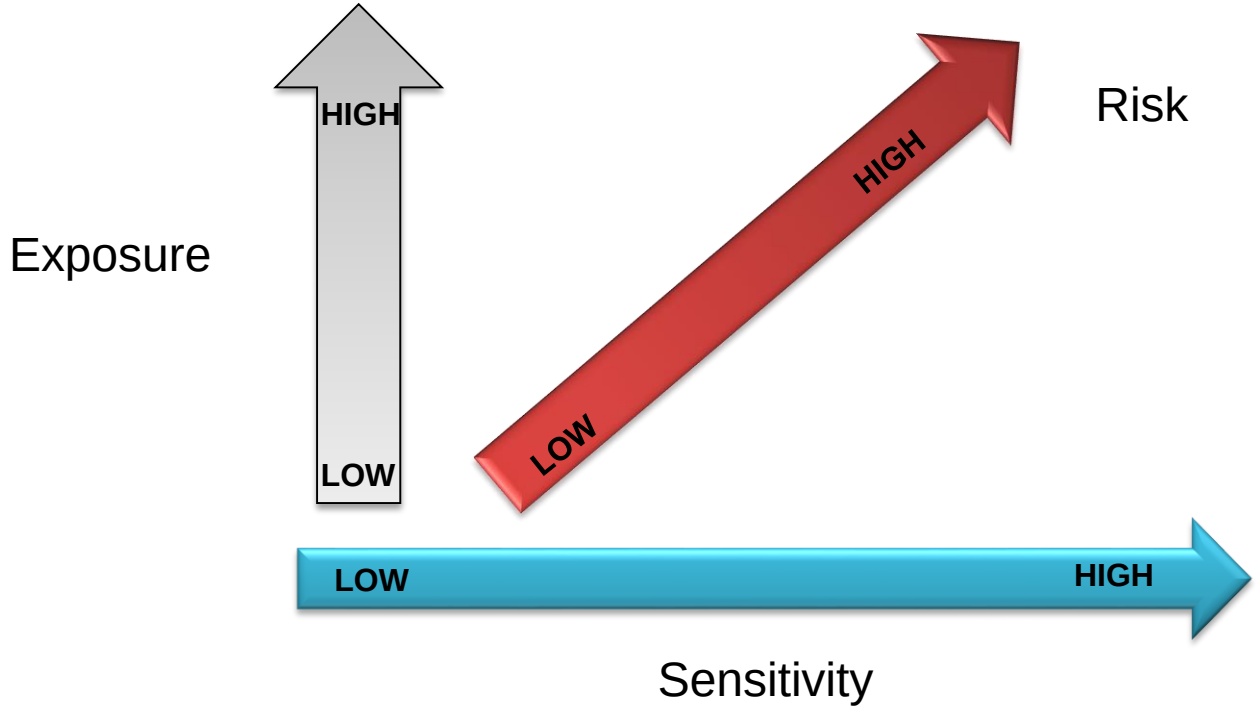
Recreation potential index (RPI). The RPI is a combined index based on degree of naturalness, presence of protected areas, presence of coastlines (lakes and sea) and quality of bathing water. Data sources: CLC2000, CAPRI model, EEA bathing water quality database, Natura 2000 database and CDDA database (Fig. A14. Maes et al. 2011, EC JRC EUR 24750 EN – 2011 doi:10.2788/63557)



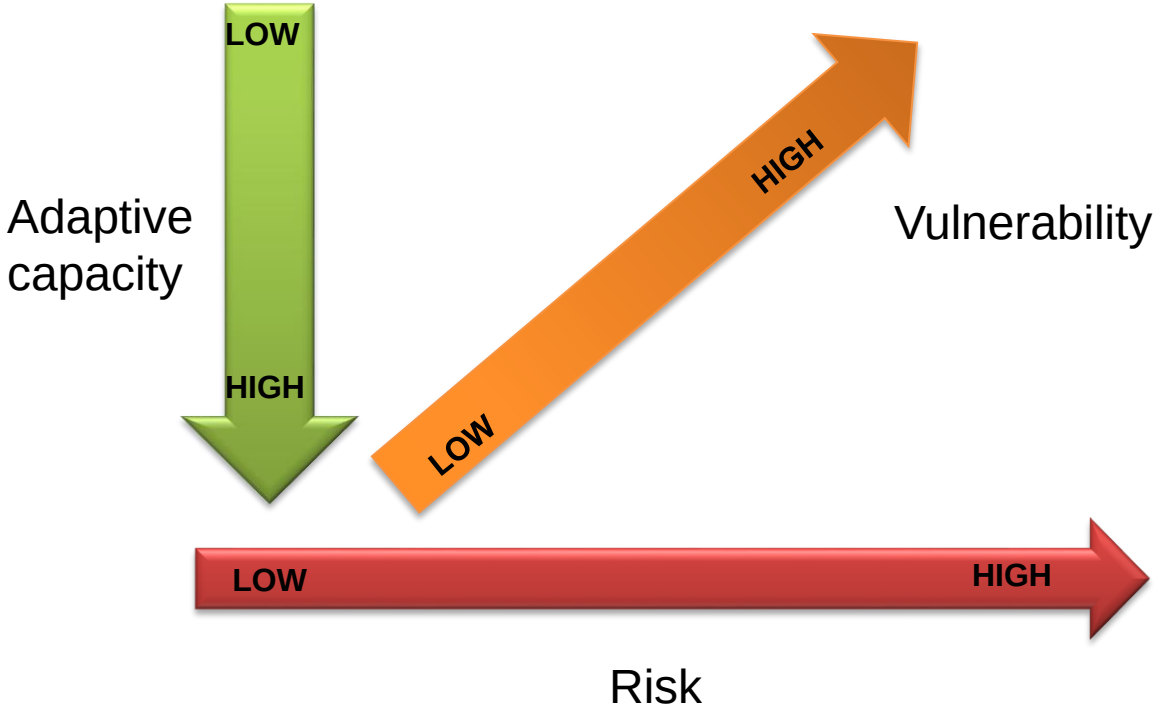
MONIMET: From Climate Scenarios to Vulnerability



Risk depends on sensitivity and exposure



Vulnerability depends on risk and adaptive capacity



MONIMET: Climate Change Indicators and Ecosystem Services

Climate Change Indicators

- Duration of Vegetation Active Period
- Vegetation Carbon Uptake Rate
- Forest and Soil Respiration Rates
- Methane Emission Rate
- Evapotranspiration
- Soil Moisture
- Length of Soil Frost Period
- Snow Cover
- Surface Albedo

Ecosystem Services

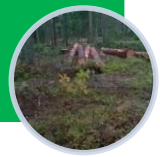
- Provisioning Services
  - Wood for timber and energy
- Regulating Services
  - Carbon sequestration
  - Water purification
  - Soil Carrying capacity
  - Avoiding drought stress
  - Avoiding insect damage
- Cultural Services
  - Recreation

Demonstration on ecosystem services and vulnerability
MONIMET Action B7

Key ecosystem services

- Wood for timber and energy

Provisioning



- Carbon sequestration
- Water purification
- Soil carrying capacity
- Avoiding drought stress
- Avoiding insect damage

Regulating

- Recreation

Cultural

Ecosystem service potential, flows and demand

- Ecosystem service potential

  The hypothetical maximum yield of selected ecosystem services

- Ecosystem service flows
  - *De facto* used set of ecosystem services in a particular area within a given time period

- Demand for ecosystem services
  - Ecosystem services currently consumed or used in a particular area over a given time period, not considering where ecosystem services are actually provided

(Burkhard et al. 2012, 2014)

Ecosystem service potential, flows and demand matrices

Service Potential	Provisioning Services		Regulating Services			Cultural Services
	Timber	Wood for energy	Carbon sequestration	Water purification	Soil carrying capacity	Recreation
Forested areas	5	4	5	4	4	5
Water bodies	0	0	0	3	0	4

0: no relevant potential; 1: low relevant potential; 2: relevant potential;
3: medium relevant potential; 4: high relevant potential; 5: very high relevant potential

To be populated based on information from statistical data and expert judgment

(adapted from Vihervaara et al. 2010, Burkhard et al. 2012, 2014)

Ecosystem service potential, flows and demand matrices

Service Flows	Provisioning Services		Regulating Services			Cultural Services
	Timber	Wood for energy	Carbon sequestration	Water purification	Soil carrying capacity	Recreation
Forested areas	5	3	3	3	1	3
Water bodies	0	0	0	3	0	2

0: no relevant flow; 1: low relevant flow; 2: relevant flow;
3: medium relevant flow; 4: high relevant flow; 5: very high relevant flow

To be populated based on information from statistical data, simulation results for projected future conditions, and expert judgment

(adapted from Vihervaara et al. 2010, Burkhard et al. 2012, 2014)

Ecosystem service potential, flows and demand matrices

Service Demand	Provisioning Services		Regulating Services			Cultural Services
	Timber	Wood for energy	Carbon sequestration	Water purification	Soil carrying capacity	Recreation
Forested areas	4	3	5	4	3	5
Water bodies	0	0	0	5	0	4

0: no relevant demand; 1: low relevant demand; 2: relevant demand;
3: medium relevant demand; 4: high relevant demand; 5: very high relevant demand

To be populated based on information from statistical data, expert judgment, projected future demand, considering current and future adaptive capacity

(adapted from Vihervaara et al. 2010, Burkhard et al. 2012, 2014)

Vulnerability in terms of ecosystem service supply and demand

Vulnerability = Demand - Supply	Provisioning Services		Regulating Services			Cultural Services
	Timber	Wood for energy	Carbon sequestration	Water purification	Soil carrying capacity	Recreation
Forested areas	4 – 5 = - 1	3 – 3 = 0	5 – 3 = 2	4 – 3 = 1	3 – 1 = 2	5 – 3 = 2
Water bodies	0 – 0 = 0	0 – 0 = 0	0 – 0 = 0	5 – 3 = 2	0 – 0 = 0	4 – 2 = 2

-5 to -2: not vulnerable
-1 to 1 : low vulnerability; 2 – 3 vulnerable; 4 – 5 highly vulnerable

To be populated by comparing Demand and Supply Matrices

(adapted from Vihervaara et al. 2010, Burkhard et al. 2012, 2014)

Example: Wood harvesting in winter conditions

- Timber in boreal forest harvested with heavy machinery, which can operate only if the soil has a sufficient carrying capacity.
- Higher and more variable air temperatures in winter, coupled with longer and more frequent rain events, may cause longer and more frequent periods during which the sites are not accessilble.
  - Example (Kokkila 2013)

    Simulated conditions for snow cover and soil frost 2021-2030 vs reference 1971-2000

    Operability criteria for harvesting :

    min. 20 cm deep soil frost and max. 5 cm topsoil thawing

    or min. 40 cm snow cover in the absence of soil frost

    Kokkila (2013) found average length of harvesting period decreased in Juupajoki, Maaninka and Kajaani. At Juupajoki 35 % shorter harvesting period in spruce forest

Example: Provisioning service, soil frost, snow cover and carrying capacity

- To evaluate the wintertime soil carrying capacity
  - Length of soil frost period
  - Soil temperature in seasonally frozen soil
    - A simplified method for calculating soil temperature in seasonally frozen soil was presented by Rankinen et al. (2004a). With this method soil temperature at a certain depth is calculated from daily air temperature observations and soil thermal conductivity. The effect of snow cover on soil temperature is taken into account through an empirical equation (Rankinen et al. 2004b) which corrects soil temperature by an empirical damping parameter and by snow depth, which can be calculated by a simple degree-day model.

Example: Demand for wintertime harvesting and vulnerability to changes in soil carrying capacity

- Evaluate the demand for wintertime harvesting
  - Statistical data on current and past harvesting schemes
  - Expert judgment
- Assess vulnerability
  - Compare demand with supply
  - Large difference -> high vulnerability
  - Small difference or positive - > low or no vulnerability

Vulnerability assessment, next steps

1. Select relevant spatial extent and resolution of key climate change indicators
2. Determine key ecosystem service supply from climate change indicators
3. Find data and expert judgement to determine demand for key ecosystem services
4. Assess vulnerability from ecosystem service supply and demand

Photo by Emmi Silvennoinen

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Thank you for your attention!

maria.holmberg@ymparisto.fi

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