Climate change impacts on EU forests and possible adaptation measures

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Europe’s rural areas in action - Facing the challenges of tomorrow
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16 - 17 October 2008, Limassol, Cyprus
Objectives of the study

- to synthesise the existing knowledge about observed and projected impacts of climate change on forests in Europe
- to review the capacity of forests and forestry to adapt to climate change (adaptive capacity)
- to analyse vulnerability of forests and forestry to climate change in different European regions
- to review potential adaptation strategies and to survey existing and planned measures in EU member states
Forest typology

Potential impacts of climate change differ between bioclimatic zones and forest types in Europe.

- **Forest typology:** *EEA forest types* (EEA 2006) linked with the *Bioclimatic map of Europe* (Rivas-Martínez et al., 2004)

Selected bioclimates:
- Boreal,
- Temperate Oceanic
- Temperate Continental
- Mediterranean

Mountainous regions are accounted as a separate region
Methodological assessment framework

- Climate change exposure for each region
- Sensitivity to the key impact factors for each region
- Key Impact Factors depending on the region
  - Impact Factors:
    - ↑ CO2
    - ↑ or ↓ Temperature
    - ↑ or ↓ Precipitation
    - ↑ or ↓ Abiotic disturb.
    - ↑ or ↓ Biotic disturbances
- Potential Impacts on the capacity of forest to provide goods and services (i.e. Wood production, Non wood products etc..) for each region
- Adaptive capacity of forests and forestry for each region:
  - Inherent adaptive capacity of forests
  - Socio-economic adaptive capacity
- Vulnerability of forests and forestry to climate change
Impact Factors: Atmospheric CO₂ increase

- increases photosynthesis rates
- increases water use efficiency
- species show variable responses
- very important effects in water limited areas like Mediterranean regions, less important in Northern latitudes

FACE Experiment assessing effects of increased CO₂ levels on the structure and function of northern forest ecosystems
Impact Factors: Changes in Temperature and Precipitation

- Temperature effects can be positive or negative depending on environmental conditions in the region.

- Higher T with sufficient P may **improve growth**.

- Rising T without increase in P or decreasing P can lead to **drought** and thus **reduce growth**.

- Some species more sensitive than others. In Mediterranean conditions most species will suffer from droughts.
Impact Factors: Abiotic disturbances (wind, snow, fire)

- Extreme weather patterns (drought, flooding, wind storms) are projected to intensify and will have several direct and indirect impacts.

- Fire and wind damage affect forest productivity, partial or complete loss of wood and cause imbalanced stand age-structures.

- Fire can have several detrimental effects on soil, e.g. loss of nutrients through volatilisation, leaching and erosion.

- Broken and uprooted trees left in forest are breeding material for insects which cause secondary damage.

- Harvesting salvaged wood is dangerous and expensive and the large volumes distorts markets.
Impact Factors: Biotic disturbances

- Direct effects on target species (herbivores and pathogens)
  - Changes in life-cycles and suitable habitats

- Indirect effects through changes in plant nutritional quality, plant resistance or community interactions
  - Storm events increase the incidence of pest outbreaks
  - Higher probability of open tree wounds allows the entry of pathogen species
Impact Factors – Summary

- Not all the impact factors are negative
- Impacts depend also on the region analysed

<table>
<thead>
<tr>
<th>Impact Factor</th>
<th>Positive Impacts</th>
<th>Negative Impacts</th>
</tr>
</thead>
</table>
| ↑ Temperature       | ↑ Growth in Northern EU                               | ↓ Growth in Mediterranean region  
|                     |                                                       | ↑ Difficulties to forest management operations in Boreal regions                 |
| ↑ CO₂               | ↑ Water use efficiency  
|                     | ↑ Forest growth                                        | -                                                                                |
| ↑ or ↓ Precipitation| ↑ P in the north will increase forest growth           | ↓ P in Southern areas will increase droughts and ↓ forest productivity           |
| Biotic disturbances | -                                                     | ↓ Forest productivity                                                            |
| Abiotic disturbances| -                                                     | ↑ Fires specially in Mediterranean regions will ↓ forest productivity and ↑ erosion |
CC Sensitivity and Potential Impacts in Europe

+ forest growth
↑ abiotic and biotic disturbances
– difficult winter harvesting

+/ – forest growth
↑ wind and fire disturbances
? Shifting species composition

+/ – forest growth
↑ wind and fire disturbances
? Shifting species composition

– forest growth
↑ fire disturbances
↑ erosion risk
Perceived impacts and link to rural development

- Boreal
- Temperate oceanic
- Temperate continental
- Mediterranean

- Forest owners; private and public
- Forest entrepreneurs and workers
- Rural communities
Climate Change Impacts and Vulnerability of European forests - Conclusions

- Rich literature on climate change sensitivity and potential impacts, but not all regions are well covered (at least in accessible literature)
- Adaptive capacity rarely studied systematically
- Vulnerability assessments of ecosystem goods and services urgently needed in most regions
Study on impacts of climate change on European forests and options for adaptation

Service Contract with DG Agriculture (Dec 07 – Nov 08)

PART 2

Review of potential adaptation options for each of the region

Evaluation of adaptation measures regarding:
- Feasibility
- Reliability
- Cost effectiveness

Survey compiling existing and planned national strategies for adapting to climate change

Contrasting results

Conclusions and recommendations for potential adaptation options for forests and forestry in the EU27
Adaptation strategies

- should aim to increase the flexibility in management of vulnerable ecosystems
- enhance the inherent adaptability of the species and ecosystem processes
- reduce trends in environmental and social pressures that increase vulnerability to climate variability

(Hulme, P.E. 2005, J. appl. Ecology 42, 784-794)

Reducing vulnerability involves both a reduction to the exposure to climate stress and an increase in adaptive capacity

(J.-E. Parry et al. 2005)
Adaptation strategies at different levels

<table>
<thead>
<tr>
<th>Level of action</th>
<th>Adaptation actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand level</td>
<td>• forest regeneration</td>
</tr>
<tr>
<td></td>
<td>• tending and thinning of stands</td>
</tr>
<tr>
<td></td>
<td>• harvesting</td>
</tr>
<tr>
<td>Forest management</td>
<td>• management planning</td>
</tr>
<tr>
<td></td>
<td>• forest protection</td>
</tr>
<tr>
<td>Policy level</td>
<td>• infrastructure and transport</td>
</tr>
<tr>
<td></td>
<td>• nurseries and forest tree breeding</td>
</tr>
<tr>
<td></td>
<td>• further adaptation</td>
</tr>
<tr>
<td></td>
<td>• integration in risk management and policy</td>
</tr>
</tbody>
</table>
Adaptation measures

Scientific perspective
- expert assessment based on review of literature

Ongoing and planned measures in EU member states
- questionnaire to Ministeries and national research institutes
Analysis of questionnaire answers

<table>
<thead>
<tr>
<th>Activity</th>
<th>Type of measure</th>
<th>Targeted measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest regeneration</td>
<td>Species/provenance selection</td>
<td>Introducing drought tolerant species</td>
</tr>
<tr>
<td></td>
<td>Regeneration technique</td>
<td>Introducing productive southern provenance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adaptation of timing of planting</td>
</tr>
</tbody>
</table>
## Number of measures at different action levels

<table>
<thead>
<tr>
<th>Level of action</th>
<th>Adaptation actions</th>
<th>Number of measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand level</td>
<td>Forest regeneration</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Tending and thinning of stands</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Harvesting</td>
<td>19</td>
</tr>
<tr>
<td>Forest management</td>
<td>Management planning</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Forest protection</td>
<td>20</td>
</tr>
<tr>
<td>Policy level</td>
<td>Infrastructure and transport</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Nurseries and forest tree breeding</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Further adaptation integration in risk management and policy</td>
<td>43</td>
</tr>
<tr>
<td>Other measures</td>
<td>Other measures</td>
<td>17</td>
</tr>
</tbody>
</table>
Boreal region

- Earlier and stronger thinnings
- Shorter rotation periods
- Better harvesting techniques on non-frozen soils

Foto: K. Sjoberg
Temperate oceanic region

- Adapt management to increased disturbance risk
- Choose better adapted species and provenances
- Close-to-nature forestry vs. exotic plantation species

Foto: T. Standovar

www.efi.int
Temperate continental region

- Afforestation facing new difficulties
- Choose drought tolerant species and provenances
- Close-to-nature forestry, more stable stand structures

Foto: A. Barbati
Mediterranean region

- Coordinated response to increased fire risk
- Management for better drought tolerance
- Research on protection against soil erosion

Foto: A. Barbati
Main motives of adaptation measures

1. Minimize impacts of disturbances
2. Ensure wood production
3. Ensure ecosystem services
Discussion points from adaptation measure survey

- Many ongoing and planned measures are focusing on reducing disturbance risks
- Very little attention on potential benefits
- More research is needed
- Dissemination of information is important (Foresters, forest owners, decision makers)
Needs for adaptation in rural areas

- Forest goods and services are important particularly in rural areas

- In regions with active forest management, forest owners need support to adapt management practices in regeneration, tending of stands, and early thinnings

- In the Mediterranean region, communities need support to secure forest ecosystem services
Conclusions

- Climate change poses great risks, but also some opportunities
- Rural areas will be strongly affected
- Suitable adaptation measures differ between regions
- Adaptive capacity is much higher in the Boreal and Temperate-oceanic regions
- The Mediterranean and Temperate-continental regions are most vulnerable and require specific support
Thank you for your attention!

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