Integrating Wind Damage Risk into the Management of Forests

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Outline of Presentation

- Wind Damage to European Forests: 1950-present
- Ecological, Social and Economic Impacts
- Factors Affecting Storm Damage
- Forest Risk Management
  - Immediate Response
  - Recovery
  - Preparation
- Risk Mitigation
- Summary
- Recommendations for the Future
Damage to European Forests

- Wind
- Other abiotic causes
- Bark beetles
- Other biotic causes
- Other causes

Damage (million m³)
## Damage to European Forests

<table>
<thead>
<tr>
<th>Country</th>
<th>Insects &amp; disease</th>
<th>Wildlife &amp; grazing</th>
<th>Storm, wind &amp; snow</th>
<th>Fires</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest area with damage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(million ha)</td>
<td>5.2</td>
<td>10.3</td>
<td>7.9</td>
<td>1.0</td>
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<tr>
<td>Represented forest area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(million ha)</td>
<td>928.1</td>
<td>968.4</td>
<td>968.9</td>
<td>93.7</td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td>(%)</td>
<td>91.0</td>
<td>94.9</td>
<td>95.0</td>
<td>9.2</td>
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<tr>
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<td></td>
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<tr>
<td>(%)</td>
<td>0.6</td>
<td>1.1</td>
<td>0.8</td>
<td>1.1</td>
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<tr>
<td>Forest area with damage</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(million ha)</td>
<td>3.4</td>
<td>4.4</td>
<td>5.1</td>
<td>1.0</td>
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<tr>
<td>Represented forest area</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(million ha)</td>
<td>119.0</td>
<td>159.3</td>
<td>159.9</td>
<td>93.7</td>
</tr>
<tr>
<td>Represented forest area</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(%)</td>
<td>56.4</td>
<td>75.6</td>
<td>75.8</td>
<td>44.5</td>
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<tr>
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<td></td>
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<tr>
<td>(%)</td>
<td>2.8</td>
<td>2.8</td>
<td>3.2</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Source: FOREST EUROPE State of Europe’s Forests 2011 Report
Damage to European Forests

- **Forest fires:**
  - In 2005, Portugal: 800 million € worth of damage and 13 casualties
  - In 2007, Greece: 5 billion € worth of damage and 64 casualties

- **Pests and diseases:**
  About 2.7% of the forest area in Europe is adversely affected by insects and diseases (new species entering Europe due to climate change)

- **Storms:**
  Responsible for more than 50% of all damage by volume in Europe:
  - In 1999, France: 180 millions m³ were destroyed = 6 billion €
  - In 2005, Sweden: 75 millions m³ were destroyed = 2.4 billion €
  - In 2009, France: > 45 million m³ were destroyed = > 1 billion €
Storm Damage To European Forests
Storm Klaus, France: 24/01/2009
Storm Impacts

- **Primary Damage (~ day)**
  - Direct damage to forest during the storm
  - Injury to people, and damage and disruption to infrastructure

- **Secondary Damage (~ weeks to years)**
  - Further damage to forest from other agents (primarily biotic)
  - Impact on biodiversity
  - GHG release from disturbed soils

- **Tertiary Damage (~ years to decades)**
  - Impacts on markets and prices
  - Long term impact on resource availability
  - Effect on employment
  - Damage to forest ecosystem services (biodiversity, water quality, recreation, carbon sequestration, etc.)
Factors Affecting Tree Stability
Forest Edges
Gaps
Species Choice
Topography
Factors Controlling Storm Damage

- **Gust peak wind speeds** can be roughly ascribed to different levels of damage:
  - $< 30 \text{ ms}^{-1}$: No damage
  - $30-40 \text{ ms}^{-1}$: Moderate damage of $<2\%$ Growing Stock
  - $40-45 \text{ ms}^{-1}$: High level of damage of $2-4\%$ Growing Stock
  - $> 45 \text{ ms}^{-1}$: Severe level of damage of $>4\%$ Growing Stock
Factors Controlling Wind Damage

- Topography can have large impact on wind speeds and damage location
- Vulnerability to wind damage is mainly a function of tree height
- Both broadleaf and conifer species can be relatively wind stable (*quercus* sp./*abies alba*) or unstable (*picea abies/populus sp.*) but on average conifers appear to be more susceptible
- Soil condition is very important and rooting strength is influenced by water-logging and heavy rain prior to damaging storms
- Recent thinning is associated with increased wind damage
- Stand structure (e.g. irregular versus regular) appears to have little influence on stability but the evidence is contradictory
- Mixed species stands including more stable species appear to have some additional stability benefit (e.g. *betula sp.* or *pinus sylvestris* mixed with *picea abies*)
Risk Management and Risk Mitigation

Risk Management Cycle

- Hazard identification
- Calculate risk
- Assess alternatives
- Implement mitigation plan
- Recovery

Prepare

- Warning
- Implement crisis plan
- Communicate

Response

- Immediate assistance
- Restore access and power
- Assess damage
- Assess markets & economic impact
- Stakeholder meetings
- Prepare roads & landing areas
- Harvest timber
- Transport timber
- Control diseases and pests

Stakeholders

- Access regional/national/European funding
- Stakeholder meetings
- Restore infrastructure
- Regional development
- Risk mitigation analysis
- Forest management planning
- Forest restoration
- On-going social & economic recovery
Risk Mitigation

1. Collect Data
2. Hazard Identification
3. Implement Plan
   - Reduce Risk
   - Spread Risk
   - Accept Risk

Spread Risk
Wind Risk Model

ForestGALES 2: A Wind Risk Management Model (WRMM)
ForestGALES: Inputs and Outputs

- Tree-pulling Experiments
- Forest Inventory
- Growth/yield model
- Wind Climate
- Terrain Conditions
- CWS: Critical Wind Speed for Damage
- EWS: Extreme Wind Speed Probability
- GIS
- Airflow Model (e.g., WAsP)
- Decision-tree Analysis

Kamimura et al. 2008 (Forestry)
Critical Heights for Maritime Pine and Eucalyptus in SW France (10% Risk)
Summary I

- Wind damage to forests has increased in Europe over the last 50 years.
- Wind damage likely to quadruple by end of century due to increased storm intensity, higher winter precipitation and reduced periods of frozen soils.
- Wind now causes more than 50% by volume of all forest damage.
- Storm damage is a common phenomena at a European level but may be infrequent at a national level (lack of collective memory).
- Recent forest damage from storms is directly linked to growing stock.
- Wind damage is a complex interaction between wind speed, storm duration, topography, site conditions and stand conditions.
Summary II

- Tree height, water-logging, recent thinning and upwind clear felling are strongly related to wind damage.
- Some species appear to be more resistant to wind damage (*quercus* sp./*abies alba*) and some species are more susceptible (*picea abies/populus sp.*)
- Management choices can reduce the risk and incidence of wind damage.
- Tools already exist to predict the probability of wind damage to many commercially important species including *picea abies, pinus sylvestris, betula sp., quercus sp.*
Recommendations

- A wind risk model should be parameterised for Belarus based on ForestGALES (or similar wind risk model).
- Risk maps (critical heights/probability of damage) for Belarus using the new wind risk model, digital terrain data, wind climate, forest inventory data, and growth models should be produced.
- Wind risk management should become an integral part of forest management in Belarus (and across rest of Europe).
- A contingency plan for managing the next catastrophic storm event should be developed for Belarus (it has taken 10 years for contingency plans to be developed for France and Nouvelle-Aquitaine).
- Engage with the European Forest Risk Facility.
Thank You