GIS analysis of peatland topo-hydrological features

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- Peatland extensions in disturbed conditions
- Phenomenon of disturbances on peatlands
- LiDAR based eco-hydrological studies of peatlands
- Conclusions
Introduction

1. Regulations of wetland (incl. peatland) management in Europe:

1. *Natura2000* – protection, conservation and restoration
   - Birds Directive, Habitats Directive

   *The role of wetlands in the Water Framework Directive*
   - protection, conservation and restoration of water resources and prevention further deterioration of aquatic and terrestrial ecosystems (incl. wetlands), - functioning is directly depending on water availability
## Introduction

### 2. Bio-geographic regions of EU

<table>
<thead>
<tr>
<th>Region</th>
<th>Countries involved</th>
<th>% of EU territory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic</td>
<td>Belgium, Germany, Denmark, Spain, France, Ireland, Portugal, Netherlands, United Kingdom</td>
<td>18.4</td>
</tr>
<tr>
<td>Boreal</td>
<td>Estonia, Finland, Latvia, Lithuania, Sweden</td>
<td>18.8</td>
</tr>
<tr>
<td>Continental</td>
<td>Austria, Belgium, Bulgaria, Czech Republic, Germany, Denmark, France, Italy, Luxembourg, Poland, Romania, Sweden, Slovenia</td>
<td>29.3</td>
</tr>
<tr>
<td>Alpine</td>
<td>Austria, Bulgaria, Germany, Spain, Finland, France, Italy, Poland, Romania, Sweden, Slovenia, Slovakia</td>
<td>8.6</td>
</tr>
<tr>
<td>Pannonian</td>
<td>Czech Republic, Hungary, Romania, Slovakia</td>
<td>3.0</td>
</tr>
<tr>
<td>Steppic</td>
<td>Romania</td>
<td>0.9</td>
</tr>
<tr>
<td>Black Sea</td>
<td>Bulgaria, Romania</td>
<td>0.3</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>Cyprus, Spain, France, Greece, Italy, Malta, Portugal</td>
<td>20.6</td>
</tr>
<tr>
<td>Macaronesian</td>
<td>Spain, Portugal</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Source: European Topic Centre on Biological Diversity (European Environment Agency)


COST-FP0601 FORMAN,
Helsinki, 6-8.Sept. 2010
3. European peatland conditions

4. Drainage for forestry

<table>
<thead>
<tr>
<th>Country</th>
<th>*Area of Drained for forestry peatlands km²</th>
<th>Drained %</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finland</td>
<td>94000</td>
<td>52.6</td>
<td>Finnish statistical 2006</td>
</tr>
<tr>
<td>U.K.</td>
<td>17550</td>
<td>31.6</td>
<td>Forest Service 2007</td>
</tr>
<tr>
<td>Estonia</td>
<td>10090</td>
<td>30.4</td>
<td>National Forest Inventory 2006</td>
</tr>
<tr>
<td>Ireland</td>
<td>11760</td>
<td>23.0</td>
<td>Forest Service 2007</td>
</tr>
<tr>
<td>Norway</td>
<td>23700</td>
<td>17.7</td>
<td>Paavilainen and Päivänen 1995</td>
</tr>
<tr>
<td>Sweden</td>
<td>104000</td>
<td>14.4</td>
<td>Hånell and Magnusson 2005</td>
</tr>
<tr>
<td>Poland</td>
<td>10880</td>
<td>11.0</td>
<td>Paavilainen and Päivänen 1995</td>
</tr>
<tr>
<td>Germany</td>
<td>14200</td>
<td>7.7</td>
<td>Paavilainen and Päivänen 1995</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>286180</strong></td>
<td><strong>28.8</strong></td>
<td><strong>Source</strong></td>
</tr>
</tbody>
</table>

GW depth: 35-55 cm

Ditch density: 25 or 50 m

i.e.
82 x 10³ km² drained area
≥ as min
1.6 - 3.3 x 10⁸ km (!) ditches

*Source:

http://www.5dvision.ee/~edelamaa/failid/tolkuse_hydro/1osa.pdf

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1. CORINE data bases

### Wetland Source Area, ha %

<table>
<thead>
<tr>
<th>Wetland</th>
<th>Source</th>
<th>Area, ha</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>fluvial &amp; coastal wetlands</td>
<td>CORINE-1995</td>
<td>32800</td>
<td>2.87</td>
</tr>
<tr>
<td>open bogs</td>
<td>CORINE-1995</td>
<td>96500</td>
<td>8.45</td>
</tr>
<tr>
<td>open fens</td>
<td>CORINE-1995</td>
<td>43300</td>
<td>3.79</td>
</tr>
<tr>
<td>wooded peatlands</td>
<td>CORINE-1995</td>
<td>140700</td>
<td>12.32</td>
</tr>
<tr>
<td>cutover peatlands</td>
<td>CORINE-1995</td>
<td>23000</td>
<td>2.01</td>
</tr>
<tr>
<td>nonidentified</td>
<td>basin map, M1:50000</td>
<td>806200</td>
<td>70.56</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1142500</strong></td>
<td><strong>100.00</strong></td>
</tr>
<tr>
<td><strong>Estonian area</strong></td>
<td>CORINE-1995</td>
<td>4533666</td>
<td>25.20</td>
</tr>
</tbody>
</table>

Source: Estonian CORINE 1995

~29.44%
Peatland extensions in disturbed conditions

2. CORINE data bases together with soil and remote sensing data bases

Estonian CORINE 1995


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Peatland extensions in disturbed conditions

2. Spatial and ground-level landscape monitoring data bases together with geological survey data bases

Sources: Swedish NILS, VMI and SGU data bases. From: SLU NILS project

Drained for forestry 79%
Drained for forestry 34% & 87%
Drained for forestry 90%
Phenomenon of disturbances on peatlands

1. Peatland surface differencation - plant cover, microtopography

Source:
Phenomenon of disturbances on peatlands

2. Areal expansion of semi-natural or secondary disturbances

Ecotope conditions
I) Ecotopes with natural microforms, 19.3%
II) Ecotopes with man made disturbances, 57.5%
III) Ecotopes with semi-natural or secondary disturbances, 15.2%

Mire lake conditions
Open water area of the mire lake (0.4% of the mire area) has been decreased 67% during ~50 years

Density of the line objects
100m/ha in fen and transitional fen part of the mire

3. Differentiation of GWL* depths over the landscape

*Source EMHI – Estonian Institute of Meteorology and Hydrology
Phenomenon of disturbances on peatlands

3. Surface slope changes
=> e.g. changes in catchment deliniation, changes in water discharges, changes in sediment and nutrient loads, changes in evapotranspiration processes, changes in GHG budgets, changes in ecological statue of the landscape etc.

LiDAR based eco-hydrological studies of peatlands

1. LiDAR scanning and mapping

- Laser altimetry ALS40-II:
  - Av. fly height - 1 km
  - Echo point density at nadir - 2.3 pm²
  - Height accuracy - 8 cm

- Data down loading - TerraScan
  - overlap; erratic high; erratic low; 0-intensity; last echo → ground; vegetation.

- Ground-level point density - 0.8 pm²

Source
http://soundwaves.usgs.gov/2003/01/Lidardiagram.jpg
LiDAR based eco-hydrological studies of peatlands

2. DEM model generation

Block schema for DEM generation

DEM models with cell size
- 1x1m
- 2x2m
- 5x5m
- 10x10m

LA

Extract

last echo

Classify

veg.

Classify

ground

Interpolate MAX surface

DSM

Interpolate TIN surface

DEM

Subtract

veg. mask

filter h>0.5

CHM
LiDAR based eco-hydrological studies of peatlands

3. 3D models for the mire landscapes

Nigula mire 3D model
cell size: 10x10m

Selisoo mire 3D model
cell size: 5x5m
LiDAR based eco-hydrological studies of peatlands

4. Boolean for the tree layer coverage

Forest coverage - 18.8% (ArcMap9.3 environment)
LiDAR based eco-hydrological studies of peatlands

5. Surface cover height distribution, linear object discovering
LiDAR based eco-hydrological studies of peatlands

5. Modelling of geographical and hydrological features, e.g. slopes, aspects, basins, fluvial pathways distances/lengths etc.
LiDAR based eco-hydrological studies of peatlands

NB! Modeling results are algorithm and scale dependent
Conclusions

- In Europe about 70% of the peatlands have been disappeared during last century; from about 290 000 km² about 30% is drained for forestry
- Expansion of forestry drainage by semi-natural ecotopes might reach up 15% (Selisoo mire case)
- LiDAR data base together with other space and ground-level data bases extremely attractive for peatland eco-hydrologists
- LiDAR based modeling is algorithm and scale dependent
Acknowledgments
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Thank You for Your attention!