Expected impacts of climate change on the distribution of peatland habitats

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Personal Introduction

- Centre for Ecological Research
  - Institute of Ecology and Botany
    - Large-scale Vegetation Ecology Group

- Current research field:
  - vegetation ecology
  - vegetation modelling
Personal link to peatlands

- First research topic at university:
  - Floating mires at Lake Kis-Balaton and other Hungarian Lakes
  - Also peat-forming ecosystems if mature
  - Interest in peatlands - visits at various Hungarian and European locations
- Current topic: potential natural vegetation modelling
  - All natural- and semi-natural habitats including peatlands
Presentation outline

- Climate change impact assessment by potential natural vegetation (PNV) models
  - Basic facts about PNV
  - (M)PNV
  - Logical background
  - Climate change impact assessment

- Climate change impact on peatlands
  - Peatlands considered
  - Climate sensitivity
  - Expected climate change impact
Potential Natural Vegetation

- Self-sustainable
- Under the abiotic requirements of a specified point
- Without human management
- Potential -> no requirement of establishment -> no constraints of
  - propagule availability
  - Spontaneous development (succession)
Extension: MPNV - probability distribution of self-sustainable vegetation

Expresses the range of self-sustainable vegetation at a certain location

Somodi et al. 2021
Modelling PNV

Gradient Boosting

Obs. vegetation + env. conditions → MPNV

<table>
<thead>
<tr>
<th>Vegetation type</th>
<th>Presence / absence</th>
<th>Likelihood in PNV</th>
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</thead>
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</tr>
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<tr>
<td>N13</td>
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</table>

Vegetation type

Vegetation type
Vegetation data

- Landscape Ecological Vegetation Database & Map of Hungary (MÉTA)
- 267813 hexagons covering the full country
- Each hexagon with natural vegetation was visited by experts
- Observed presence/absence of mature vegetation types -> 39 habitat models

35 ha hexagons
Explanatory variables

- Climate - bioclimatic variables derived from
  - precipitation
  - temperature
- Soil characteristics
  - sand vs. clay fractions
  - rooting depth
  - organic matter content
- Hydrology
  - distance to water bodies
  - ground water levels
- Topographic position index

Precipitation sum per year
Modelling PNV

Gradient Boosting

Obs. vegetation + env. conditions

PNV

Vegetation type

Presence/absence

MPNV

Likelihood in PNV

Vegetation type

Obs. vegetation

Vegetation type

Vegetation type

B1a 0 ❌
B1b 1 ✔️
... 
N13 1 ✔️

B1a 0 😞
B1b 4 😊
... 
N13 2 😞
MPNV of Hungary

- Potential distribution map per all 39 (semi)natural vegetation types
- Probability distribution of potentially self-sustainable vegetation types per location
  - 35 ha hexagons matching the MÉTA database
Climate change impact assessment

- Site requirements quantified by MPNV models
- Site conditions updated with climate change scenarios
  - Multiple climate models
  - Multiple emission scenarios
- Predicted distribution of a vegetation type e.g. beech forests
Current climate change projections (CMIP6) for Hungary

- Temperature up
Current climate change projections for Hungary

- CMIP6!
- Precipitation?
Climate change impact on peatlands

- Peatlands (International Peatland Society):
  - terrestrial wetland ecosystems
  - waterlogged conditions
  - prevent plant material from fully decomposing
  - production of organic matter exceeds decomposition -> accumulation of peat.
- Thus wide range of ecosystems
Peatlands in Hungary

- Raised bogs with Sphagnum - rare
- Fens (Eriophorum, Molinia)
- Tussock sedge communities
- Oligotrophic reeds (Phragmites, Thelypteris)
- Willow mire (Salix cinerea)
- Swamp forests (Fraxinus, Alnus)
Climate sensitivity

- The share of climate variables in the explanation of variance in the distribution
- Change in surface water (rivers, lakes drying out) not considered
- Top sensitivity is typically not in wetlands
  - Water supply mitigates the effect of climate change
  - Resistance to drought to a certain point
  - Buffers extreme precipitation events
- But in the top ten: 3 peatland habitats
Climate sensitivity of peatland habitats in Hungary

- Willow mire 62%
- Swamp forests 58%
- Oligotrophic reeds 57%
- Tussock sedge communities - 46%
- Rich fens - 44%
- Fens (Molinia) - 34%
- Bogs not modelled due to rarity
Expected effect of climate change - oligotroropic reeds
Expected effect of climate change - Molinia meadows
Expected effect of climate change - swamp forests
Contrast: beech forests
Conclusions

- Relatively high climate sensitivity
- However climate change impact is not straightforward
- May be positive if the excess precipitation will not be diverted by agriculture
  - Irrigation, drainage
- Drought period expected in July and August under climate change,
  - but the areas harboring peatlands have a lack of water drainage
  - may buffer this short drought thanks to the overall precipitation increase
- The interplay of human response to climate change (increasing temperature) and the new climate has an uncertain outcome
Thank you for your attention!