Integrated Assessment of Climate Change Mitigation and Adaptation Impacts at Landscape level in the Austrian Mostviertel Region

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Global change at landscape level

- Climate change
- CAP reforms & climate change policies
- International market developments
- Land use & livestock management
- Farm welfare
- Abiotic environmental impacts
- Biodiversity
- Landscape appearance

3 weeks

-70%
Case study landscape

**Mostviertel**
geological transition zone between flat land (Danube valley, N) and alpine region (Nördliche Kalkalpen, S)

Farms: N=118

Farms: N=113

1250mm | 7-8°C

1000mm | 8-9°C

Methods and Data

Input
- natural & socio-economic data
  - input and output prices
  - CAP
  - production functions
  - farm labor supply
  - livestock – herd sizes
  - observed land use
  - spatially explicit field data
  - landscape elements
  - climate scenarios
  - topography
  - soil characteristics

Models
- CropRota\(^1\)
- EPIC\(^2\)
- CALDIS VÂTIS\(^4\)
- FAMOS[space]\(^3\)

Output
- socio-economic & RD indicators
  - farm gross margin
  - public budget spending
  - farm labor demand
  - landscape diversity & appearance
- agri-environmental indicators
  - agric. & forestry land use change
  - biodiversity
  - SOC
  - soil sediment loss
  - N & P nutrient balances
  - GHG emissions
- food production indicators
  - crop & livestock production

\(^2\)e.g. Izaurralde et al. (2006). Ecol Modell 192, 362-384.
\(^3\)Schönhart et al. (2011). J Environ Plann Manage 54, 115-143.
\(^4\)Georg Kindermann, BFW (see Kirchner et al., 2014). Ecol Econ (in press).
## Impact, mitigation & adaptation scenarios

<table>
<thead>
<tr>
<th>Name</th>
<th>CC*</th>
<th>AEP*</th>
<th>CAP reform</th>
<th>Mitigation policies</th>
<th>Adaptation policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>REF_2040</td>
<td>No</td>
<td>No</td>
<td>no dairy quota; no livestock premiums; regional farm payment; greening; LFA payments from 2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS[CC]_i</td>
<td>Yes</td>
<td>No</td>
<td>like REF_2040</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS[CC]_m</td>
<td>Yes</td>
<td>No</td>
<td>like REF_2040</td>
<td>energy crops on set aside; subsidies for: landsc. elements, SRF, afforestation, cover crops, min. tillage and extensive land use</td>
<td></td>
</tr>
<tr>
<td>CS[CC]_a</td>
<td>Yes</td>
<td>No</td>
<td>like REF_2040</td>
<td></td>
<td>no greening, subsidies for maintenance of steep slope grass land and irrigation</td>
</tr>
<tr>
<td>CS[CC]_ma</td>
<td>Yes</td>
<td>No</td>
<td>like REF_2040</td>
<td>like CS[CC]_m</td>
<td>like CS[CC]_a</td>
</tr>
</tbody>
</table>

* CC...climate change, AEP...agri-environmental program

### Climate Change [CC] Scenario Name

<table>
<thead>
<tr>
<th>Climate change in 2040</th>
<th>∆ temperature (°C)</th>
<th>∆ precipitation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS01</td>
<td>+1.5</td>
<td>0%</td>
</tr>
<tr>
<td>CS05</td>
<td>+1.5</td>
<td>+20%</td>
</tr>
<tr>
<td>CS09</td>
<td>+1.5</td>
<td>-20%</td>
</tr>
</tbody>
</table>
Results – changes in average aggregated farm gross margins from climate change and policies

Northern landscape

Southern landscape

**Gross margin:** + product sales (plant, livestock) + subsidies + annuities for long-term investment - variable costs (machinery, inputs and services, off-farm labor)
Results – changes in farm gross margins from climate change and policies

Northern landscape
Results – land use change from climate change and policies

Northern landscape – fallow land

Southern landscape – orchard meadows
Results – soil management

Northern landscape
Results – changes in GHG emissions from climate change and policies

Northern landscape
Results - farm land biodiversity indicators from climate change and policies

Northern landscape
Results – ACVV* indicator for landscape appearance

* Agricultural crops and vegetables value
Discussion

- Increasing productivity from climate change on average in both landscapes
  - In line with some of the literature, but not all
  - What about extreme weather events?
- Increasing farm incomes on average from assumed mitigation and adaptation policies
  - Mitigation policy increases environmental quality at the cost of public budgets and agricultural production
  - Flexibility from adaptation shows trade-offs between ag. production and env. protection
- Location determines impacts
  - Heterogeneous climate change impacts among regions and farms
  - Not only latitude but altitude to be considered as well in impact studies
Conclusions

• High spatial resolution creates interfaces to disciplinary models and indicators
  • Challenging data demand
• Increasing productivity can increase intensification pressures
  • Threatened permanent (extensive) grasslands and landscape elements, but
  • subject to resource constraints, costs and prices
  • Future RDP and environmental policy design (e.g. WFD) should take changing productivity into account
• Future research: analyze uncertainties
  • Ensembles of crop and grassland models
  • Sensitivity analysis on economic input parameters
  • Alternative model settings to test model uncertainty
  • Expert survey on observed and expected changes to complement modelling
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## EPIC – model run settings

<table>
<thead>
<tr>
<th>Input Data</th>
<th>Management</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field</td>
<td>Tillage</td>
<td>irrigation</td>
</tr>
<tr>
<td>slope</td>
<td>Intensity</td>
<td>Crop yield/forage yield</td>
</tr>
<tr>
<td>elevation</td>
<td></td>
<td>Above ground biomass</td>
</tr>
<tr>
<td>ACLiReM Climate change (precipitation) scenarios</td>
<td></td>
<td>Sediment yield</td>
</tr>
<tr>
<td>CS01 +0%</td>
<td></td>
<td>Runoff</td>
</tr>
<tr>
<td>CS05 +20%</td>
<td></td>
<td>Evapotranspiration</td>
</tr>
<tr>
<td>CS09 -20%</td>
<td></td>
<td>Nutrient loads (N, P)</td>
</tr>
<tr>
<td>Periods</td>
<td></td>
<td>Nutrient uptake (N, P)</td>
</tr>
<tr>
<td>1990-2005</td>
<td></td>
<td>Soil organic carbon</td>
</tr>
<tr>
<td>2025-2040</td>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>

### Crop Rotations
- **Conventional**
  - high
  - moderate
  - low
- **Reduced**
  - high
  - moderate
  - low
- **Cover crops**
  - high
  - moderate
  - low

### Grassland
- **1-cut/3-cut**
  - high
  - moderate
  - low
  - irrigation
Outlook
Analysis of trade-offs and synergies

Kirchner et al., 2014. Ecological Economics (in press).
Outlook
Landscape visualization