Climate adapted transition in land use – a GIS-based adaptive management approach

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ECCA, Hamburg, 18th of March 2013
northwest2050 – sectors and areas

Duration 2009-2014 (BMBF)

Sectoral approach:
- Energy
- Agriculture
- Harbor and logistics

Climate adaptation innovation paths:
- Regulation of land use conflicts
- Transformation in energy and agricultural sector

2050
Roadmap of Change
Analysis of regional land use (2009-2011)

- Assessment of CC-vulnerability, structure of actors, interests and conflicts

- Energy
- Agriculture

- "Energiewende" Biogas production
- Energy infrastructure
- Health of soils
- Water quality
- Fragmentation
- Lease prices
- Excess manure
- Pests and diseases

Decisions under uncertainty

14.03.2013
IS for decision support

IS-Tool aims at closing methodical gap (cross scale issues; cf. Cash et al. 2006) by

• Visualizing concrete problems in context of actors
• Providing pre-post evaluation for specific land use changes
• Integrating and stressing ecological boundaries in (long term relevant) decisions.

→ Ecosystem service* based approach
→ Decision support for regional experts

* „Ecosystem services are the aspects of ecosystems utilized (actively or passively) to produce human well-being.“ (Fisher et al. 2009).
IS for land use management

Figure: own
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>9,22°C</td>
<td>+1,5°C (+1 bis +2°C)</td>
<td>+2,8°C (+1,9 to +4,7°C)</td>
</tr>
<tr>
<td>Precipitation</td>
<td>734 mm</td>
<td>+8% (+3 bis +9%)</td>
<td>+6% (-1 to +10%)</td>
</tr>
<tr>
<td>• in Summer</td>
<td>208 mm</td>
<td>-3% (-13 bis +8%)</td>
<td>-17% (-46 to -9%)</td>
</tr>
<tr>
<td>• in Winter</td>
<td>168 mm</td>
<td>+9% (+9 bis +27%)</td>
<td>+25% (+17 to +44%)</td>
</tr>
</tbody>
</table>

- Increase of extreme precipitation patterns and extreme heat
- Decrease of extreme cold and snow
- More stormy days and maximal wind speed
- Higher storm flood water level

Schuchardt et al.2010 (averages: A1B; spans: B1, B2, A1B, A2; Models: CLM, REMO, WETTREG, RCAD)
Stakeholder Involvement

- Framing and assessment of
  - Problem scope/ Status Quo
  - Socio-economic feasibility (e.g. conflicts and interactions)
- Decision support/ dealing with consequences

→ Dialogue and communication processes to improve adaptation capacity (applied resilience)
→ Visualization shows ecological dangers and dependencies
An application case: Cloppenburg (county in MR Bremen-Oldenburg)

Early summer dryness \(\rightarrow\) Large area irrigation \(\rightarrow\) High consumption of water and dramatic nutrient pollution in ground water (excess manure & increased biogas production residues) \(\rightarrow\) Problems for fisheries, drinking water, and small enterprises

\(\rightarrow\) Land use conflicts are coupled with availability and quality of water.

<table>
<thead>
<tr>
<th>CLOPPENBURG:</th>
<th>Source: LWK 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total land 141 831 ha:</td>
<td></td>
</tr>
<tr>
<td>Arable land 70%: 99 798 ha</td>
<td><strong>Plowland 73,50%: 73 365 ha</strong> Grassland 23%: 23 020 ha</td>
</tr>
<tr>
<td>Urban land 13.3% + Woods 12 %</td>
<td></td>
</tr>
<tr>
<td>Maize cultivation: 2003</td>
<td>2011</td>
</tr>
<tr>
<td>Total 34 890 ha</td>
<td>48 547 ha</td>
</tr>
<tr>
<td>„Silomais“ 18 040 ha</td>
<td>33 270 ha</td>
</tr>
</tbody>
</table>

\(\rightarrow\) 2011 nearly 50% of arable land devoted to biogas maize; 2013 ~60%
Mapping of status quo

**ES1 Soil productivity**
- 31: Crop yield average
- 183: # biogas plants
- 87: Installed MW

**ES2 Water**
- Rivers
- Evaluation of nitrate pollution in ground water
- Consulting area nitrate reduction
- Examples of water shortage

**ES3 Landscape and recreation**
- Nature protection areas, quality, fragmentation
- Tourism/recreation hotspots
- # of citizens initiative against biogas plants/ loss of cultural landscape

Data references: see back up
Land use change „more maize“:
- Impacts on ES under climate change
- Stakeholder factor in as capacity to actively buffer negative impacts.

Figure: own; ES1 Soil productivity, ES2 Water, ES3 Landscape and recreation

14.03.2013
Technical Realization

1. Status Quo (GIS)
2. Model
3. GIS-based Visualization
4. Stakeholder Involvement

Realization of technical prototype: follow up project

14.03.2013
Thank you!

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Selected references

Beddington J, Asaduzzaman M et al. (2012) Achieving food security in the face of climate change: Final report from the Commission on Sustainable Agriculture and Climate Change, Copenhagen and Denmark.


Groot R de, Fisher, B et al. (2010) The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations; Chapter 1: Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation


Scheele U, Oberdörffer J (2013 im Erscheinen) Flächenmanagement vor großen Herausforderungen. nordwest2050-Werkstatthericht, Oldenburg


14.03.2013 Dr. Nana Karlstetter
Digital base map 500 ÜK, NLÖ
http://www.energymap.info/energieregionen/DE/105/116/178/589.html (last access 14.03.2013)

Lüneburg
http://www.umwelt.niedersachsen.de/portal/live.php?navigation_id=26048&article_id=88735&psmand=10 (last access 14.03.2013)

Umweltdaten Niedersachsen
http://www.umwelt.niedersachsen.de/portal/live.php?navigation_id=2540&article_id=9124&psmand=10 (last access 14.03.2013)

Umweltdaten Niedersachsen

Oldenburg
http://www.nwzonline.de/wirtschaft/weser-ems/hohe-nitratbelastungen-im-kreis-cloppenburg-nachgewiesen_a_1.0.498434914.html (last access 14.03.2013)
http://www.nwzonline.de/oldenburg-kreis/wirtschaft/bauern-feilen-an-erscheinungsbild-in-der-oeffentlichkeit_a_1.0.2872521110.html (last access 14.03.2013)
http://www.nwzonline.de/cloppenburg/bildung/kein-wild-barssels-jaeger-sagen-ihrer-hubertusjagd-ab_a_1.0.1788638845.html (last access 14.03.2013)
http://www.lohne-wehrt-sich.de/ (last access 14.03.2013)
## Scale and cross-scale challenges

<table>
<thead>
<tr>
<th>A. Spatial Areas</th>
<th>B. Temporal Rates, Durations, and Frequencies</th>
<th>C. Jurisdictional Administrations</th>
<th>D. Institutional Rules</th>
<th>E. Management Plans</th>
<th>F. Networks Links</th>
<th>G. Knowledge Truths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Globe</td>
<td>Fast Short</td>
<td>Inter-Governmental</td>
<td>Constitutions</td>
<td>Strategies Trans-society</td>
<td>Society</td>
<td>General Universal</td>
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<td>Regions</td>
<td>Annual</td>
<td>National</td>
<td>Laws, Regulations</td>
<td>Projects Kin</td>
<td>Kin</td>
<td>Specific Contextual</td>
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<tr>
<td>Landscapes</td>
<td>Seasonal</td>
<td>Provincial</td>
<td>Operating Rules</td>
<td>Tasks Family</td>
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<tr>
<td>Patches</td>
<td>Daily</td>
<td>Localities</td>
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</tbody>
</table>

Cash et al. 2006, modified
Relations between land use types

Available land MR Br-OI

Arable land used for food production
- Live stock farming
- Crop food products
- Dairy production

Biogas production

Other sectors (tourism; housing and traffic; ...)

Environmental conservation

Competition:
- crop food products vs. biogas production
- other sectors vs. environmental conservation

Policies

Ecosystems

Figure: own
Challenges facing climate change and adaptation: land use perspective

Transformation energy sector
- Increasing production of renewable energy
- Expansion up- and downstream energy infrastructure

Transformation agriculture
- Intensive industrialized production vs. Sustainable production
- Energy vs. Food production

Land use
- Impacts i.e. climate warming, sea level rise, extreme weather conditions
- Long term uncertainties

Climate change

Climate adaptation
- Technical adjustments
- Space consuming measures
Challenges facing climate change and adaptation: planning perspective

- Understanding and managing complexity and uncertainty is greatest challenge.
- Traditional linear planning and decision making methods are unlikely to be effective.
- Mismatches between long-term uncertainties and short time planning horizons cause problems for climate adaptation measures.

Figure: Biggs et al. 2011, modified

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Development biogas-production

2001-2010 Lower Saxony

(Number of biogas plants)  Produced electricity (MW)

Cultivation of energy plants for biogas in % of arable land

2011 → 2013: + ~50 plants