The Integrated Tool for Economic and Ecological Modelling ITE²M: Assessment of trade-offs in landscape services

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“Agricultural land use practices are changing, leading to changes in the economic structure and in landscape services”*

- Land use change: direction, rate, intensity?
- Affected areas: identification, localization?
- Ecological, economic and social consequences?

*) Costanza et al., Nature 387, 253-260
ITE²M

- Required: An integrated assessment of land use change effects

ITE²M - Integrative Tool for Ecological & Economic Modelling

- Context: Joint Research Project
  "Land Use options for peripheral regions"
  (Sonderforschungsbereich SFB 299)

for details and list of publication: www.sfb299.de
ITE²M

Integrated Tool for Ecological and Economic Modeling

Land use scenarios

AGENDA

Cropland
Forest
Pasture

Ecosystem services
- Capacity for work
- Land rent
- Soil quality (heavy metals)
- Water quantity
- Water quality (N, P)
- Erosion protection
- Flood control
- Drinking water availability
- C sequestration
- Trace gas emissions
ITE$^2$M components

- **ProLand** - Prognosis of Land use \((Sheridan \ et \ al.)\)

- **GEPARD** - Geographically Explicit Prediction of Animal Richness Distribution \((Gottschalk \ et \ al.)\)

- **ProF** - Prognosis of Floristic richness \((Waldhardt \ et \ al.)\)

- **ANIMO** - Effects of landscape pattern on species diversity \((Kostrzewa \ et \ al.)\)

- **CHOICE** - Policy analysis and evaluation \((Borresch \ et \ al.)\)

- **SWAT** - Soil Water Assessment Tool \((Breuer \ et \ al.)\)

- **ATOMIS** - Assessment Tool of Metals In Soils
Research Area

Dill catchment
Size ~ 692 km²

54.4 % forest
20.5 % pasture
9.2 % settlement
9.1 % fallow
6.5 % agriculture
Scenario: Agenda 2000 vs. CAP Reform

Land use and management scenarios investigated:

→ Base scenario: current general conditions as created by the **Agenda 2000**
  • Crop specific area payments and animal premiums

→ Reforms of the **EU Common Agricultural Policy**:
  • Replace area payments with decoupled area payments
  • Drop coupled animal premiums
ProLand: Prognosis of land use change

Model ProLand result; Weinmann, Kuhlmann et al. 2005
## Land Use Scenarios – Model ProLand

<table>
<thead>
<tr>
<th>Category</th>
<th>Agenda2000</th>
<th>CAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest [%]</td>
<td>74.8</td>
<td>59.1</td>
</tr>
<tr>
<td>Pasture [%]</td>
<td>6.0</td>
<td>30.3</td>
</tr>
<tr>
<td>Urban [%]</td>
<td>9.2</td>
<td>9.2</td>
</tr>
<tr>
<td>Cropland [%]</td>
<td>9.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Surface waters [%]</td>
<td>0.3</td>
<td>0.3</td>
</tr>
</tbody>
</table>
ProLand
...calculates economic measures given environmental and economic conditions
...provides spatially differentiated land use maps
Water flux flow chart [mm] for precipitation, evapotranspiration, surface runoff, lateral flow and baseflow
13% Reduction of nitrate load due to differences in land use distribution and management
Soil Quality – Model ATOMIS

Percentage of agricultural land showing exceedance of precautionary value of Copper in the soil
1. Standardization
2. Definition of targets values for each ecosystem service

Targets were defined as follows:

*high* for capacity of work, land rent, added value → economic production

*low* for NO$_3^-$ loads → water quality

*low* for percentage of exeedance of heavy metal precautionary values → soil quality

*low* for discharge, evapotranspiration → water quantity

Example: Higher capacity of work defined as target, as it provides an opportunity to reduce unemployment rate in the region. The capacity of work for AGENDA was calculated to be 37% less effective.
Target values are (subjectively) grouped to ecosystem services. ITE2M evaluation: CAP is superior for most ecosystem services.
**Conclusion & Outlook**

**ITE²M**

...provides a valuable tool for analyzing ecosystem services.
...further model structures are easy to implement.
...has a limited flexibility to calculate feedback mechanisms.

→ ITE²M is now being used in other regions (Nidda catchment, South Hessia) for a proof of transferability.

→ Scenarios with the current trends in agricultural markets (Bioenergy, higher milk price) and effects of climate change will be established.

→ Focus now on floristic and faunistic biodiversity.