Impact of ecosystem changes on land use functions in Jinghe Watershed of Western China

Yunjie Wei¹, Lin Zhen¹, Hannes Köenig²

¹ IGSNRR, CAS; ² ZALF

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Outline

• Land Use Function
• Study Area
• Methods
• Results
• Conclusion & Discussion
Impact of ecosystem changes on land use functions in Jinghe Watershed of western China

Land Use Function

- Agriculture
- Forestry
- Nature Conservation
- Transport Infrastructure
- Energy
- Tourism

Multifunctional land use

Social

- Provision of work
- Human health & recreation
- Cultural & aesthetic values

Economic

- Industry & services
- Land based production
- Infrastructure
- Abiotic resources
- Biotic resources
- Ecosystem processes

Environment

- Abiotic resources
- Biotic resources
- Ecosystem processes

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Research Questions

• Which are the main Land Use Functions and its indicator in study area?
• How did they change on temporal and spatial?
• Which kind of methods is the best for impact assessment of ecosystem changes involved stakeholders and expert knowledge?
Study Area

- 32 counties
- N34°14’ ~ 38°10’
- E105°49’ ~ 108°58’

- Lack of water

- Main land use
  - Arable land
  - Forest land
  - Grassland
## Methods - FoPIA

**Pillar Land Use Functions First**

<table>
<thead>
<tr>
<th>Social</th>
<th>Economic</th>
<th>Environmental</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUF1 Provision of work</td>
<td>LUF4 Residential and non-land industry and services</td>
<td>LUF7 Provision of abiotic resources</td>
</tr>
<tr>
<td>6.8</td>
<td>6.3</td>
<td>6.5</td>
</tr>
<tr>
<td>LUF2 Quality of life</td>
<td>LUF5 Land based production</td>
<td>LUF8 Provision of biotic resources</td>
</tr>
<tr>
<td>7.5</td>
<td>8.3</td>
<td>7.6</td>
</tr>
<tr>
<td>LUF3 Food security</td>
<td>LUF6 Infrastructure</td>
<td>LUF9 Maintenance of ecosystem processes</td>
</tr>
<tr>
<td>7.4</td>
<td>5.5</td>
<td>7.4</td>
</tr>
</tbody>
</table>

**Scoring**

- **Social**
  - LUF1 Provision of work: 6.8
  - LUF2 Quality of life: 7.5
  - LUF3 Food security: 7.4
- **Economic**
  - LUF4 Residential and non-land industry and services: 6.3
  - LUF5 Land based production: 8.3
  - LUF6 Infrastructure: 5.5
- **Environmental**
  - LUF7 Provision of abiotic resources: 6.5
  - LUF8 Provision of biotic resources: 7.6
  - LUF9 Maintenance of ecosystem processes: 7.4
Methods-PRA

- Loacal ecosystem services
  - Products
  - Services
  - Changes

- Questionnaire
  - Consumption
  - Human well-being
Methods: Pro-Vision (ZALF)

- Each LUF is linked to the individual sustainability-contribution of a single land use type. Pro-Vision uses Expression to evaluate the land use function and the function change.

\[
LUF = \sum \left( \frac{N_i}{N} \cdot W_i \right)
\]

- Where, \(N_i\) is count of grid (land use area), \(N\) is sum of count (total regional land use area), and \(W_i\) is weight value of the corresponding land use type.
**Methods: Pro-Vision (ZALF)**

<table>
<thead>
<tr>
<th>Land use type</th>
<th>LUF1</th>
<th>LUF2</th>
<th>…</th>
<th>LUF9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arable land</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Forest land</td>
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</tr>
<tr>
<td>Grassland</td>
<td></td>
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<tr>
<td>Water area</td>
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<tr>
<td>Built-up area</td>
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<tr>
<td>Unused land</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Land use type</th>
<th>Area percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arable land</td>
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<tr>
<td>Forest land</td>
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<tr>
<td>Grassland</td>
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</tbody>
</table>

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**Methods: Pro-Vision (ZALF)**

<table>
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<tr>
<th>Land Use Type</th>
<th>LUF1</th>
<th>LUF2</th>
<th>...</th>
<th>LUF9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmland</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Forestland</td>
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<tr>
<td>Grassland</td>
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<td>Water area</td>
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<tr>
<td>Built-up area</td>
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<tr>
<td>Unused land</td>
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<tr>
<td>Total</td>
<td></td>
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</tr>
</tbody>
</table>
# LUFs Weight Value in Jinghe Watershed (0-100)

<table>
<thead>
<tr>
<th>Land Use Type</th>
<th>Arable land</th>
<th>Forestland</th>
<th>Grassland</th>
<th>Water area</th>
<th>Built-up area</th>
<th>Unused land</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pillar</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>LUFs</strong></td>
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</tr>
<tr>
<td>Social LUFs</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>LUF1 Provision of work</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>20</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>LUF2 Quality of life (income)</td>
<td>60</td>
<td>40</td>
<td>50</td>
<td>30</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>LUF3 Food security</td>
<td>100</td>
<td>30</td>
<td>30</td>
<td>20</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Economic LUFs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LUF4 Residential and non-land industry and services</td>
<td>30</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>LUF5 Land based production</td>
<td>100</td>
<td>70</td>
<td>60</td>
<td>30</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>LUF6 Infrastructure</td>
<td>30</td>
<td>30</td>
<td>20</td>
<td>20</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>Ecological LUFs</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>LUF7 Provision of abiotic resources (clean water/ air)</td>
<td>60</td>
<td>80</td>
<td>60</td>
<td>80</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>LUF8 Provision of biotic resources (biodiversity)</td>
<td>70</td>
<td>100</td>
<td>80</td>
<td>70</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>LUF9 Maintenance of ecosystem processes</td>
<td>80</td>
<td>100</td>
<td>90</td>
<td>50</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>
Spatial analysis

Raster Calculator

Land use map × LUFs weight value → Land use function map

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Results

Environmental LUFs in 2005 in Jinghe

LUFs in 2005 in Jinghe

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## Influencing Indicators

<table>
<thead>
<tr>
<th>SOCIAL</th>
<th>ECONOMICAL</th>
<th>ENVIRONMENTAL</th>
</tr>
</thead>
</table>
| **Water:**  
  - quality  
  - quantity | **Provision of work and non-industrial activities** | **Provision of abiotic resources** |
| **Air:**  
  - Pollution  
  - GHG emissions | | |
| **Quality of life** | | **Provision of biotic resources** |
| **Biodiversity:**  
  - forest coverage  
  - the number of species | | |
| **Soil:**  
  - Sealing  
  - Wind & Water erosion  
  - pollution  
  - organic C | | **Maintenance of ecosystem processes.** |

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Conclusions

- Combined FoPIA and spatial land use function analysis in Pro-Vision
- It identifies 9 LUFs and indicators in Jinghe Watershed
- Try to LUFs spatial analysis
- Methods
Discussion

• Simulate LUFs in the future based on policy
• Optimise future land use
• Increasing local people’s income from land
Acknowledgement

• SENSOR Project of EU FP6
• Special Programme of Ministry of Technology and Sciences, P. R. China

• Our partners in ZALF
• All stakeholders
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Thanks very much for your attention!

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