Implications of ecosystem amenities as drivers for urban development: a social-ecological system model for Stockholm, Sweden

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Ecosystem Amenities and Urban Development

- Natural Amenities have been important factors for locational choices of companies and residences.
- Compared to traditional modelled drivers for urban growth (such as density/agglomeration, transportation, commuting), how does natural amenities play a role in driving urban growth?
- By understanding the “natural drivers”, can we design policy instruments with NBS to promote more sustainable urban transition?

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Social-Ecological Models

- One of the major frameworks to analyze and assess the impacts from urban growth and policy instruments (for example, nature-based solutions) is through social-ecological models.
- A social-ecological model needs to find the interface between social and natural systems and their feedbacks.
- Methods include land use/cover models, augmented input-output models/CGE, behavior models, etc.
Feedback-loop between economy-land-ecosystem

- We propose a model that integrates land use, regional economics, and most important, ecosystem as drivers of land use growth, and assess the impacts on ecosystem.
System process of economy-land-ecosystem
System modeling to reach innovative policy instruments (NBS)

1. Calibrating Model
2. Forecasting
3. Relate Future Land Use to Ecosystem Impacts
4. Policy intervention with NBS
5. Test Policy Instruments

Future Land Use Change Probability
- Overlay on Ecosystem Accounting
- Risks of Ecosystem Service Loss
- Potentiality of NBS locations on Urban Development
- Innovative Policy Instrument (NBS)
### Table 1. Explanation of variables (attractors)

<table>
<thead>
<tr>
<th>Attractor</th>
<th>Data Value</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Center</td>
<td>Number of Population</td>
<td>Chicago: US Census</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stockholm: TRF</td>
</tr>
<tr>
<td>Employment Center</td>
<td>Number of Employment</td>
<td>Chicago: D&amp;B Hoovers Database</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stockholm: TRF</td>
</tr>
<tr>
<td>Transportation Network</td>
<td>Posted Speed</td>
<td>Chicago: US Census</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stockholm: TRF</td>
</tr>
<tr>
<td>Forest</td>
<td>Area of Forest</td>
<td>Chicago: NLCD Land Cover</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stockholm: TRF and Swedish Land Survey Authority</td>
</tr>
<tr>
<td>Water</td>
<td>Area of Water Surface</td>
<td>Chicago: NLCD Land Cover</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stockholm: TRF and Swedish Land Survey Authority</td>
</tr>
</tbody>
</table>
Calibration

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Figure 2. Relationships between connectivity to attractors and commercial developments for Chicago and Stockholm.

Figure 3. Relationships between connectivity to attractors and residential developments for Chicago and Stockholm.
What about ecosystem drivers?

### Commercial:
Better ecosystem services strongly attract commercial development.

### Residential:
Better ecosystem services has an even stronger draw to residential development. However, there are significant developments within very low ecosystem service values.
Forecast Probability of Urban Development

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- Probability of commercial growth
- Probability of residential growth
- High
- Low
Forecast Probability of Urban Development

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- Probability of commercial growth
- Ecosystem service value accounting

Legend:
- High development, low ecosystem services
- Low development, high ecosystem services
- High development, high ecosystem services
- Low development, low ecosystem services
Policy Interventions with NBS

- **For high development high ecosystem services areas:** ecosystem services need to be protected with natural buffers to avoid future development (such as greenbelt); also other strategies need to be used to attract these developments to other areas.

- **For high development low ecosystem services areas:** these areas need to be provided with artificial forestry&greening and recreational activity opportunities in the limited ecosystems.
Policy Interventions with NBS

- For low development high ecosystem services areas:
  These trends are preferred and should be implemented in planning.

- For low development low ecosystem services areas:
  ecosystem services should be designed with better recreational opportunities to attract growth that were to occurred at high ecosystem service areas.
Policy Interventions with NBS

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Example NBS interventions:
- Improving recreational ESV to attract developments that were to disturb high natural ESV areas
- Shifting out or prevent developments that disturb high natural ESV.

Improving recreational ESV to attract developments that were to disturb high natural ESV areas

Shifting out or prevent developments that disturb high natural ESV.
Test policy instruments (to be cont...)

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Preventive Zoning

Design, Forestry + greening, green belt

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