Synergies and trade-offs between local and global ecosystem services in Costa Rica

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Ecosystem Services: “The benefits people obtain from ecosystems”

- Climate regulation
- Water purification
- Pollution control
- Water regulation
- Soil protection
- Scenic beauty
- Cultural heritage
- Spiritual values
- Pollination
- Genetic resources
- Wood
- Food
- Fuel and energy
Introduction

- Economic instruments for conserving ES
  - Payment for Ecosystem Services (PES)
- Costa Rica
  - PES at the national scale
  - Mainly for forest conservation (91% of the area)
  - Four recognized ES:
    - Biodiversity conservation
    - Carbon sequestration
    - Hydrological services
    - Scenic beauty
  - No real targeting of payments

How to target PES?

- Three factors (Naidoo et al., 2008)
  - Level of ES provision, depending on:
    1. ES production by ecosystems
    2. Use of ES by human populations where the ES flow
  - ES additionality, depending on:
    3. Risk of land use conversion
- Possible trade-offs:
  - E.g. for a given ES:
    - high level but low risk
  - For various ES
    - High level of provision of one ES but low level of the others
Questions

Does the conservation of one ES contribute to the provision of the others?

Are there synergies between biodiversity, local services (water, scenic beauty) and global services (carbon)?

Are there areas with high level of provision of the four ES?

Approach

- Mapping at the national scale
  - Resolution: from 0.25 to 20 km
    - Clearer results with 4 km
- 4 maps:
  - Biodiversity
  - Carbon sequestration
  - Hydrological services
  - Scenic beauty
Ecosystem service mapping: Overview

Introduction

Methods

Results & Discussion

Conclusion

Fuzzy logic

- Modeling with rules:
  - E.g. IF (Production of ES by ecosystems is high) AND (Presence of humans benefiting from ES is HIGH) THEN (level of ES is high)

Fuzzification → Fuzzy inference → Defuzzification
Results and discussion

Analyzing synergies

<table>
<thead>
<tr>
<th>Low ES₁</th>
<th>High ES₁</th>
<th>Low ES₂</th>
<th>High ES₂</th>
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<tbody>
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<td></td>
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<td>Trade-off</td>
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<td>Synergy</td>
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Synergy Index = \[
\frac{\text{Area(synergy)}}{\text{Area(synergy)} + 0.5 \times \text{Area(trade-off)}}
\]
Most biodiversity hotspots are far from population or tourists.

More water hotspots in the mountains but more carbon in lowlands.
Biodiversity and water

Role of protected forests in the mountains, upstream of big cities

Water and scenic beauty

Large patch of protected forests near cities and tourist places provide both water services and scenic beauty
Conclusion

- Synergies and tradeoffs:
  - Synergy between local services (water and scenic beauty)
  - Biodiversity conservation contributes to local services (water)
  - Prioritizing carbon may not favor local services
- Identification of hotspots for certain ES:
  - In the Costa Rican PES, many buyers of individual ES
- It is possible to identify hotspots of several ES:
  - Importance of protected forests upstream of populated places:
    - Water, biodiversity and scenic beauty at the same place

Thank you!