Human Appropriation of Net Primary Production (HANPP) Analysis of Rural to Urban Transition at the Watershed Scale in the Southeastern United States

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**Introduction**

- The human appropriation of net primary productivity (HANPP) is a socio-ecological indicator that quantifies the effects of human-induced changes in biomass flows within ecosystems.
- Most HANPP research is done at the global, regional, or country scale.
- We examined HANPP at the watershed scale to quantify the rural-to-urban transition currently shaping the Piedmont.
- High resolution analysis possible at the watershed scale allowed quantification of HANPP in urban environments that are characterized by complex and changing spatial heterogeneity.

**Methodology**

- Rocky Creek (36 km\(^2\)) and Gilder Creek (22 km\(^2\)) watersheds are located in the southeast United States, in a temperate forest biome and the southern Piedmont ecoregion.
- Land cover classification map from NLCD and previous land cover classifications in Andersen et al. (2015) were used to organize different land cover types for a comparable analysis.
- Land cover types were digitized from aerial photographs of 1965 and 2013 using ArcMap10.1.
- High resolution analysis of four low intensity and four medium intensity residential neighborhoods analyzed the land cover distribution in the urban mosaic.
- Estimates of agricultural harvest were based on data for Greenville County collected from 1964 and 2012 USDA Census of Agriculture. Estimates of forest harvest were based on data for Greenville County from the South Carolina Forestry Commission.
- HANPP calculations adapted from Andersen et al. (2015) and Haberl et al. (2007).

**Results and Discussion**

**Watershed HANPP Analysis**

<table>
<thead>
<tr>
<th>Year</th>
<th>Rocky Creek</th>
<th>Gilder Creek</th>
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</thead>
<tbody>
<tr>
<td>1965</td>
<td>60.0%</td>
<td>55.0%</td>
</tr>
<tr>
<td>2013</td>
<td>60.0%</td>
<td>55.0%</td>
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Between 1965 and 2013, forest cover and pasture decreased and row crop nearly disappeared. Urbanization led to the expansion of residential and commercial land cover at the expense of agriculture.

**High Resolution Neighborhood Analysis**

- **Land cover analysis:**
  - 1965: Rocky Creek and Gilder Creek watersheds.
  - 2013: Rocky Creek and Gilder Creek watersheds.

- **High resolution analysis:**
  - Low density residential and four medium density residential neighborhoods.
  - Urban land cover is a complex mosaic of turf grass, forest, and impervious surface.
  - High resolution results: low density residential is 29.8% turf grass, 26.1% impervious, and 43.8% forested; medium density residential is 21.6% turf grass, 52.0% impervious, and 26.4% forested.

**Conclusion**

- HANPP was driven primarily by land use change rather than biomass harvest.
- Urbanization between 1965 and 2013 was mainly residential development and led to a slight reduction in HANPP.
- From a socio-ecological perspective, a major impact on biomass flows away from food production and other services provided by agriculture.
- Understanding the estimation of HANPP in urban environments requires high resolution analysis. Low and medium density residential land covers are characterized by minimal decline in HANPP.
- Future research will include analysis of more watersheds with different levels of urbanization and analyzing the connection between ecosystem services, biodiversity, and HANPP.

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