Life Cycle Assessment of Ecosystem Services for Phoenix Building Stock

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Introduction

Ecosystem services are crucial to sustaining human existence, yet are generally poorly accounted for in urban sustainability assessments. More comprehensive, transparent, and robust methods are necessary for holistic understanding of urban technosphere and ecosphere systems, including their interfaces. Ecosystem services are often indirectly gained from the natural environment, so the linkages between human activity and declining in ecosystem services are not always well understood. Including ecosystem services in life cycle assessment (LCA) is an important step to provide rigorous environmental impact accounting to decision makers.

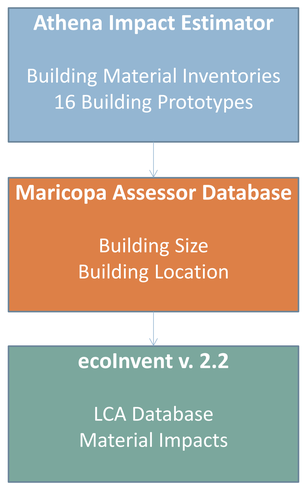
Goals

1) To do exploratory research on including ecosystem service indicators into Life Cycle Assessment (LCA) in order to quantify large-scale ecosystem service impacts of human activities
2) To spatially locate the manufacturing processes and associated environmental impacts
3) To perform a case study on the buildings in Maricopa County

Methodology

1) Prototype Creation

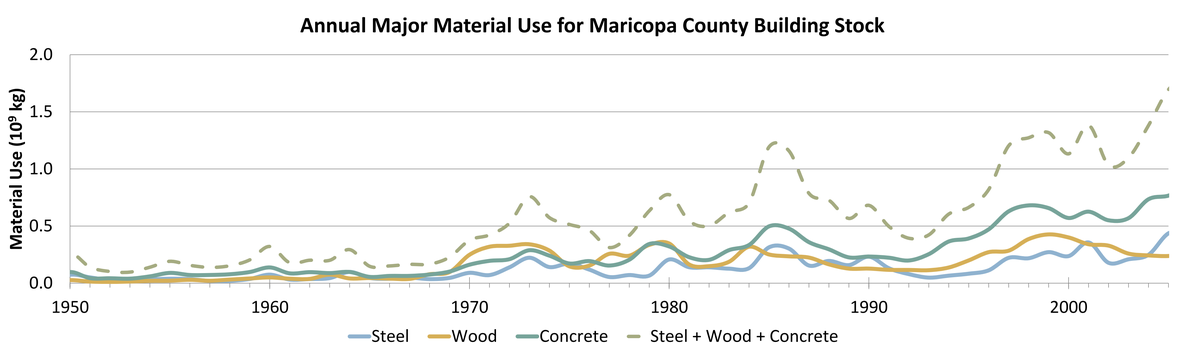
- Athena Building Estimator is used to build prototype material inventories
- EcoInvent Database version 2.2 material processes are joined with the prototypes to determine impacts
- The impacts are normalized by land area
- The normalized factors are joined with the Maricopa County assessor data



2) Spatial Disaggregation

- For major raw materials, annual production of Arizona is catalogued annually 1950 to Present
- Arizona material production is compared to material consumption each year within construction industry
- Materials with the majority of production outside of the state for a given year are designated “remote”
- Manufacturing ecosystem service impacts of “remote” materials are likely to occur outside to Arizona.

Results

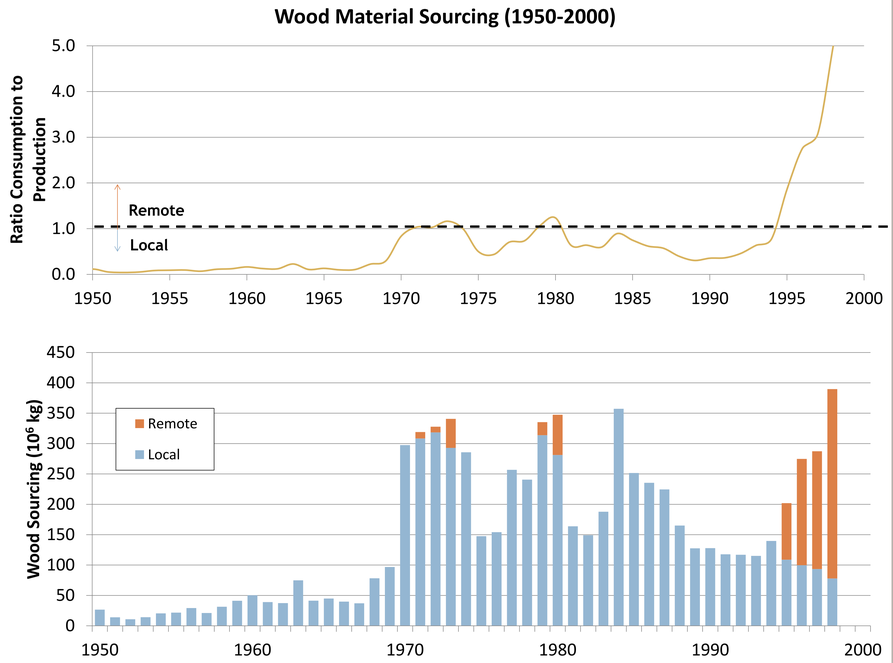


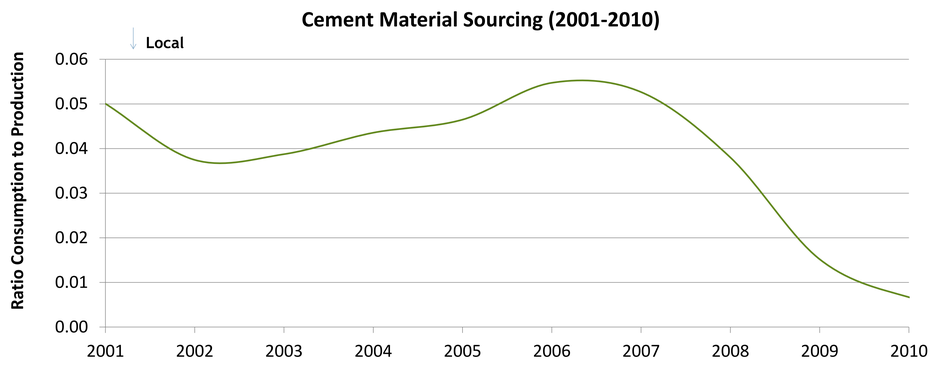
Material Use in Building Infrastructure by Year

Annual material usage for the construction of buildings has steadily increased over time with the expanding population of Phoenix. The three main materials by mass observed in the building stock were: steel, wood, and concrete.

Remote Wood Sourcing

- Increasing wood consumption in the construction industry has triggered increasingly remote supply chains over time.
- For wood, sourcing has likely shifted from within Arizona to out-of-state sources
- Impacts of material production have also shifted across political boundaries and ecological regimes
- Understanding and managing impacts is more complex with these remote supply chains





Counter-Example: Cement

- Cement has continually been sourced locally
- Currently only 1% of Arizona cement production is used for building construction
- Material sourcing varies with natural resource availability and economic factors

Results

Acidification mapping for a portion of the Phoenix building infrastructure. This map shows the total amount of acidification triggered by the construction of a building. Raw material extraction and manufacturing for many building components occur outside of Phoenix, so the triggered acidification could be in In the case of remote supply chains the actual acidification could have outside Maricopa County boundaries

Impact Methodology	Ecosystem Service Category
Cumulative Energy Demand	Provisioning
Cumulative Exergy Demand	Provisioning
Ecosystem Damage Potential	Regulating / Supporting
Ecological Footprint	Regulating / Supporting
TRACI	Regulating / Supporting
EDIP	Regulating / Supporting

Impact Methodologies and Ecosystem Service Coverage

Multiple impact methodologies were used from the ecoInvent database to give a range of impact categories. Samples from the EDIP Acidification are presented below. All of the methodologies except for TRACI are Europe-specific methodologies, and must be cautiously interpreted for the United States due to differences in processes and ecosystems. Lack of spatial resolution in the databases is a challenge to including ecosystem service vectors Here they’ve been mapped to the most closely related category of ecosystem services

Future Work

- In-depth evaluation on the importance of location on environmental impacts from building activities
- Increasing spatial resolution of supply chain tracking, tagging both US regions and international countries of origin

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