Spatially-explicit Carbon Footprinting of Populations

Emily P Quesada, with Caroline LeFloch, Ben Mandel & Svetlana Zenkin

contact email: emilyq@berkeley.edu

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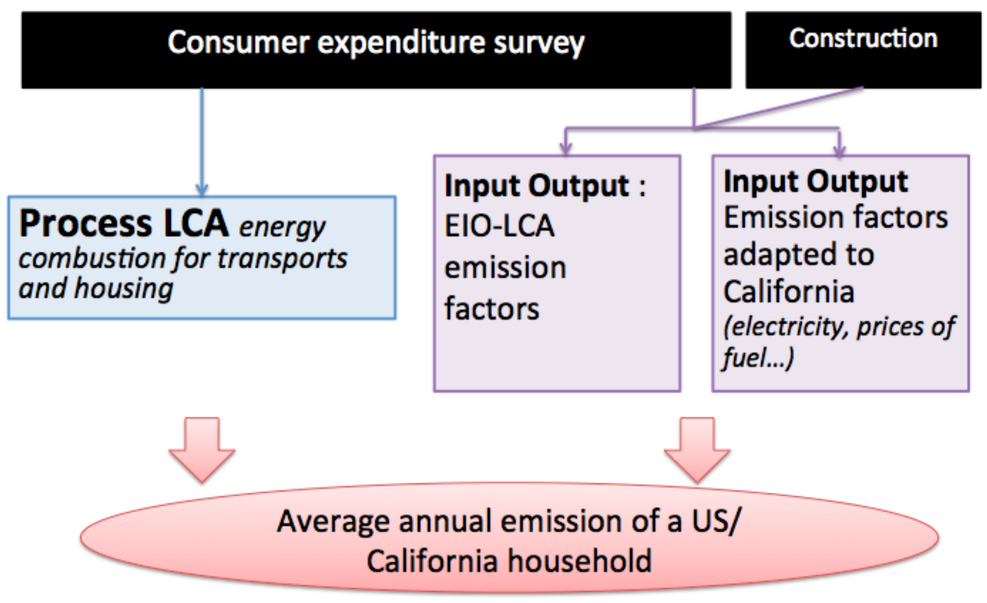
- Apply environmentally extended economic input-output emissions factors to household consumption to broaden geographic carbon footprinting beyond tailpipe emissions.
- Characterize different urban modes: many people assume urban living is more sustainable. EIO-LCA analysis brings rigor to this question.
- This study applied these methods to a comparison between California and the rest of the United States, but the method can also be used on larger or smaller scales.

Background

- Most analyses of environmental footprints of regions focus on tailpipe and smokestack emissions and neglect upstream emissions associated with consumption.
- Hoornweg et al. (2011) found that residents in Canadian urban cores emit less than one third the GHGs per capita than their rural counterparts if direct emissions only are measured. However, when embedded emissions are included, the difference nearly disappears.
- Studies including indirect emissions have found weak connections between urban density and per capita emissions in Finland (Heinonen and Junnila, 2011a and 2011b), the United Kingdom (Minx et al., 2013), and Australia (Weidenhofer et al., 2013).

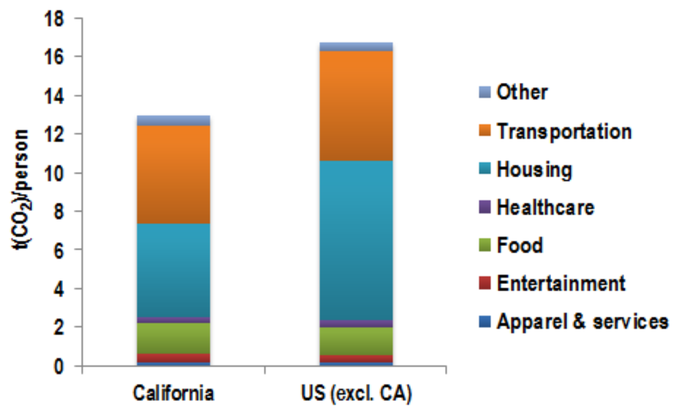
Method: Hybrid Life-Cycle Assessment



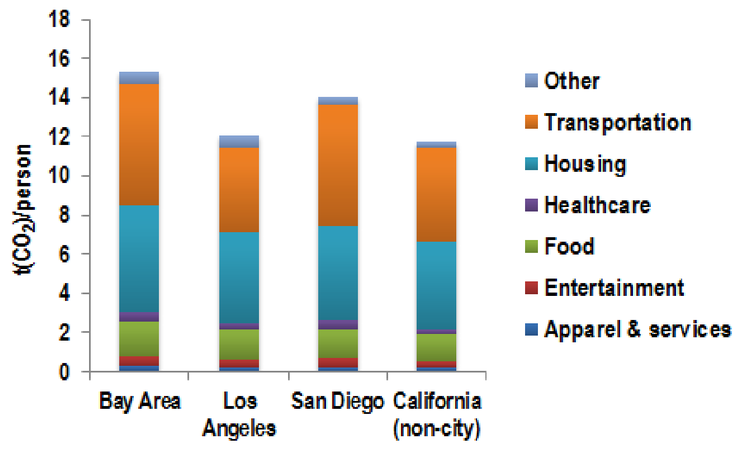
- Hybrid Life-Cycle Assessment
  - Expenditures extracted from Consumer Expenditure surveys (CEX): 125,000 respondents across US with 700 consumption categories. The CEX sectors were then matched with EIO-LCA sectors.
  - Most consumption categories processed with environmentally extended economic input-output emissions factors.
  - Expenditures on energy (home heating, electricity and gasoline) were analyzed with a process LCA.
  - Construction information is not well-represented in consumer expenditure surveys, so the surveys were supplemented with data from the Construction Industry Research Board.

Unexpected Results

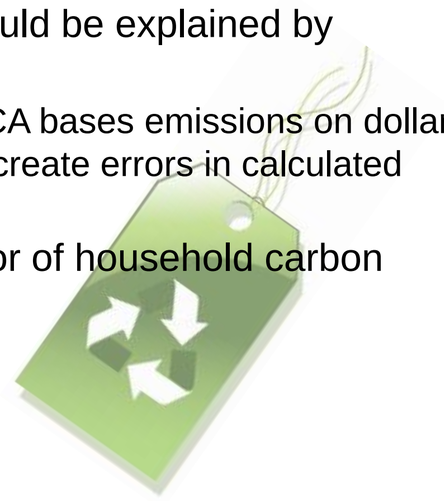
- Footprint of an average Californian is lower than American average. This is driven largely by California's low-carbon electricity mix, which is included in the blue Housing category below.
- Disparities are driven by differences in emissions from utilities, fuels, and public services.



- Bay Area footprint is near U.S. average.
  - Dominated by housing, transportation, and food
- Transportation footprint in L.A. is below CA average.



- The hybrid EIO-LCA method can be applied to different urban forms to evaluate both direct and embedded emissions of regions.
- Some of the surprising results could be explained by variations in costs of living.
  - Environmentally-extended EIO-LCA bases emissions on dollars spent, so spatially uneven prices create errors in calculated carbon footprints.
- Confirmation that the top predictor of household carbon footprint is household income.



- Add cost of living adjustments.
- Add additional years of data.
- Does household size have an impact on per capita emissions?
- Divide oversized statistical areas or metropolitan regions into regions that more precisely reflect lifestyles.
- Account for tradeoffs in price vs. climate impact that are popularly believed to drive environmental purchasing decisions.
  - For example, organic food is often more expensive, but may have a lower carbon footprint.