Ecosystem across a gradient of urbanization. To systematically evaluate patterns and carbon budgets mechanisms linking urban activities affect \( C / f_\text{luxes} \) and urbanizing regions provide biogeochemistry in processes, and concentration of fossil fuel combustion gradient of urbanization. Chapter 12 in Brown, D.G., Robinson, D.T., French, N.H.H., and Reed, Conterminous US. "Global change Biology, 16: 135-143.

References

Table 1 provides a synthesis of what is known to date of the relationships between urban patterns and carbon stocks and fluxes, and what is presently uncertain or unknown. Our synthesis focuses on four main characteristics of urban patterns, including urban form (clustered vs. dispersed), density (high vs. low population density), connectivity (degree of integration of the transportation infrastructure), and heterogeneity (land-use mix). Urban Patterns and Carbon: A Synthesis

Table 1 Urban Patterns and Carbon Stocks and Fluxes^1^ Synoptic table relating dimensions of urban patterns to carbon stocks and fluxes along a gradient of urbanization. For example, increasing land-use intensity increases energy use and produces changes in microclimate (increase in temperature) that affect carbon \( /f_\text{luxes} \). Arrows point in the direction of increasing urban form (clustered vs. dispersed), density (high vs. low population density), connectivity (degree of integration of the transportation infrastructure), and heterogeneity (land-use mix).

Conceptual Framework and Hypotheses

Building on mechanisms established in the literature that link urban patterns and the C cycle (see Table 1), we articulate a framework (Figure 2) and set of testable hypotheses on how these mechanisms vary across a hypothetical gradient of urbanization (Figure 3).

We identify five key mechanisms that affect change in \( C \) stocks and \( /f_\text{luxes} \) along an urban gradient^2^.

1. What factors control changes in carbon stocks and \( /f_\text{luxes} \) along a gradient of urbanization? H1: Variability in carbon stocks and \( /f_\text{luxes} \) across gradients of urbanization is controlled by complex interactions between land cover, emissions, organic inputs, temperature, and \( N \) fertilization.  

2. What are the tradeoffs between stocks and \( /f_\text{luxes} \) associated with patterns of urbanization? H2: Carbon stocks and \( /f_\text{luxes} \) vary across an urban-to-rural gradient in relation to household characteristics, their residential location preferences, and travel behaviors, which affect land cover and transportation emissions.  

3. What are the uncertainties, lags, and feedbacks associated with urban land use and infrastructure decisions on carbon stocks and \( /f_\text{luxes} \)? H3: The relationships between urban patterns and carbon stocks and \( /f_\text{luxes} \) are influenced by natural and land-use legacies.  

4. How will the interactions between urbanization patterns and carbon processes evolve under future scenarios? H4: Urban development choices are sensitive to carbon mitigation policies, but their ability to shape the urban structure is highly dependent on the existing built infrastructure.  

Box 1 Mechanisms affecting terrestrial carbon stocks and \( /f_\text{luxes} \) along an urban gradient^2^.

We identify five key mechanisms that affect change in \( C \) stocks and \( /f_\text{luxes} \) along a gradient of urbanization: land cover change, emissions, organic inputs, temperature, and \( N \) fertilization. Taken together, we hypothesize that these five mechanisms will produce nonlinear variations in \( C \) stocks and \( /f_\text{luxes} \) across the urban gradient. The amount of \( C \) in vegetative biomass (and \( /f_\text{luxes} \)) is expected to generally increase with decreased development intensity, with a small peak in the older suburbs and exurbs where larger lots have had time to accumulate biomass following initial clearing. Fluxes (per unit mass) might be expected to decrease with decreasing temperatures and decreased \( N \) and CO\(_2\) fertilization but ultimately be highest in the least dense areas because of the large amount of photosynthetically active vegetation in forests.

Conclusions

• The Seattle metro area has a remarkable magnitude of \( C \) stocks — findings point to a complex relationship between land use and climate across the urban to rural gradient.  

• Empirical data for diverse sources of \( C \) sinks is critical to understanding the mechanistic relationships of the urban C cycle.  

• Patterns of rapid urban expansion have important implications for future scenarios of net emission reductions.  

• Installation of towers can support long term monitoring of carbon fluxes with the aim of supporting informed policy.  

• Scenarios, leveraging observations and a mechanistic understanding, can explore alternative and divergent trajectories of land use land cover change in order to test policy strategies.