The climate limits of construction in over 1000 cities

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Summary

Rapid growth of urban construction threatens global climate targets. Cities have a lot of influence over what gets built and the associated greenhouse gas (GHG) impacts. However, cities across the globe have largely overlooked the challenge of reducing construction-related greenhouse gas emissions, which generally happen upstream and outside local administrative boundaries (e.g. emissions from production of construction materials). Construction stakeholders lack information on how much GHG emissions construction is causing, limits to how much GHG construction can emit in the future, and by extension the reductions required to get from one to the other.

To provide guidance on past/current GHG emissions and future reduction needs, we calculate construction emissions and carbon budgets for over 1,000 cities across the world. We estimate construction emissions using an economic model called an environmentally-extended input-output model (EEIO) along with statistical regression techniques. We set carbon budgets by dividing up the world's global carbon budget – which is the overall pie of allowable future emissions – and allocating a share to the cities based on their population or emissions. These budgets set a cumulative limit on how much each city can emit from their construction activities in the future. We then divide the overall emissions budget evenly among expected future buildings to outline the emissions per unit/building that align with climate limits. We also built a public, interactive dashboard that can be used to visualize the construction footprint and carbon budgets of one or multiple cities. The dashboard can be viewed HERE.

Key Takeaways:

1) **The footprint of construction tracks with urban development across the world** – Construction in most high-income cities is responsible for 1 to 3 $MtCO_2e$ annually per capita (Fig 1). This means that by 2030, construction alone could use up many cities' entire carbon budget (~1 $MtCO_2e$ per capita annual). Increasing investment is driving the footprint of low-income cities closer to the footprint of high-income cities.

2) **Meeting climate limits requires immediate, unprecedented mitigation** – Cities must reduce their emissions to 10% of 2019 levels by no later than 2060 to meet a 2°C budget (Fig 2). The exact year depends on whether the budget is distributed equally among all humans, or grandfathered based on the status-quo (based on share of current emissions).

3) **Near-term demand for construction can be met within climate limits through existing designs in many cities, but it requires large changes in how we build** – For example, the city of Toronto aims to build 285,000 housing units by 2032. On a per-unit basis, this allows for a budget of 4-17 $MtCO_2e$ per unit. Meeting this per-unit budget requires a shift to smaller, multi-unit housing (Fig 3). In low-income, fast growing cities (e.g. Delhi), meeting the budget while also increasing living standards (e.g. m^2/cap) will require significant (60-80%) per unit reductions. This burden can be alleviated by incorporating fairness adjustments into budgets.

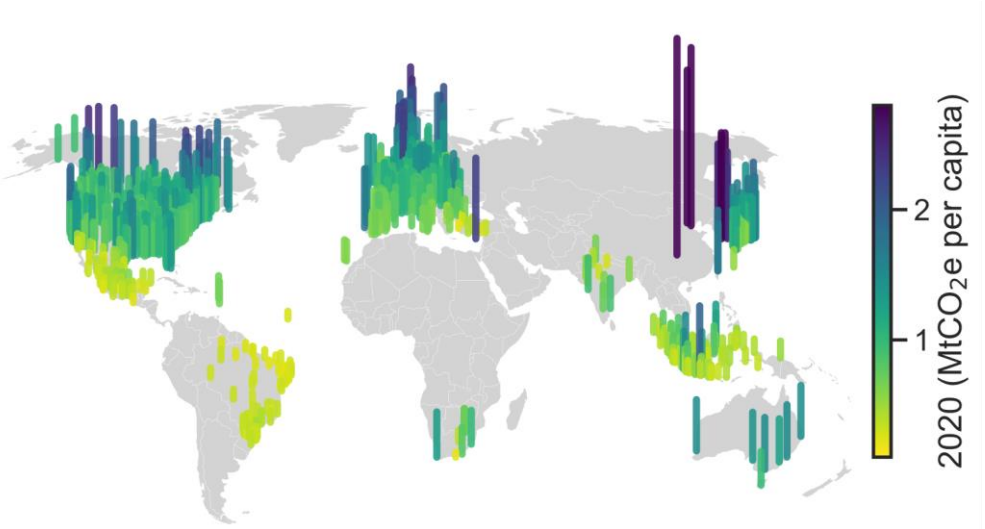

Figure 1 – Annual construction GHG emissions per capita of all 1000+ quantified cities in 2020. We estimate construction emissions between 2000 to 2020.

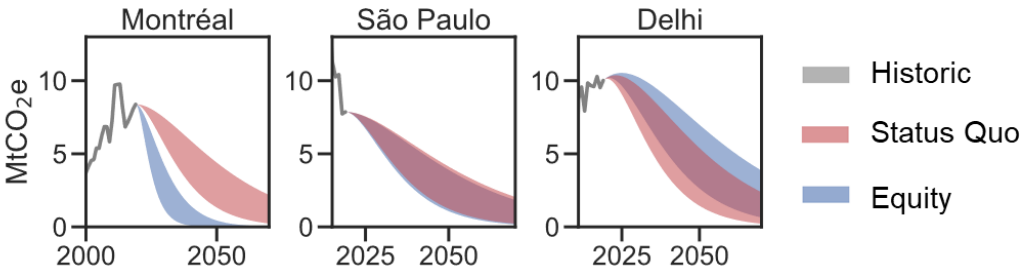

Figure 2 – Examples of city-level budgets, using either a budget distributed equally to every human (blue), or one that assumes a 'grandfathered' status-quo convergence of emissions at net-zero (red).

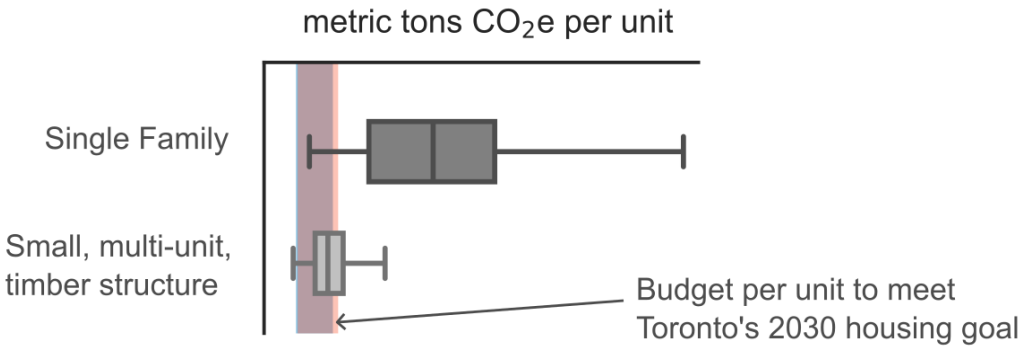

Figure 3 – Comparing the emissions of building a housing unit to the carbon budget of the City of Toronto divided by the number of houses it expects to build to meet its 2032 housing goal. This assumes no change in how materials are produced.