Urban green space: global assessment of potential energy demand reduction in buildings

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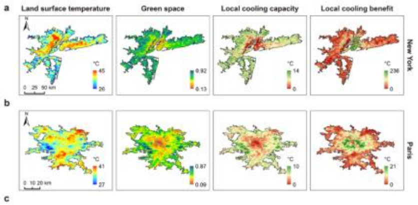
QR: Falchetta and Hammad's preprint

Context & objectives

Climate change → increasing **heat exposure and related risks** → **rising** energy use for adaptation (**thermal regulation) in buildings.**

Previous evidence of **temperature reduction effect of urban green space (UGS)** in cities (e.g. Li et al. 2023):



… but no generalizable empirical estimates for impacts on energy consumption for indoor thermal regulation energy demand! Although AC use and related electricity demand is surging and expected to skyrocket (e.g. Asia and South East Asia; MENA region, as in UN's 2023 report).

Aim of this study: estimate the potential of UGS to reduce cooling energy use in buildings across cities and countries → evaluate role of UGS as a nature-based solution to jointly support climate change **mitigation and adaptation** efforts.

Materials & methods

Two **case studies (CS)** selected based on availability of granular electricity demand data:

1- ARERA province-level (NUTS3) hourly electricity consumption data for Italy in 2021-2022, average residential customer

2- OECD/IEA metropolitan areas yearly panel (2004-2018)

The data is combined with **heat exposure** metrics derived from **ERA5 historical climate** data (Tmax, Cooling Degree Days) and with **UGS canopy cover density** estimates based on Falchetta and Hammad (2024)'s approach.

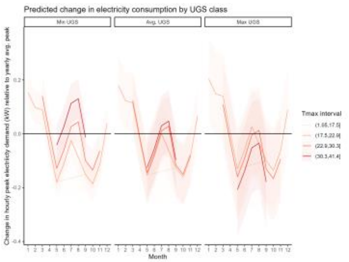
The following regression models are estimated to evaluate the response of peak/total electricity consumption to hot temperatures ($HEAT_{it}$) conditional on UGS density (UGS_{it}):

$$ELY_{it} = f(HEAT_{it} \times UGS_{it}) + Z_{it} + \xi_i + \mu_t$$

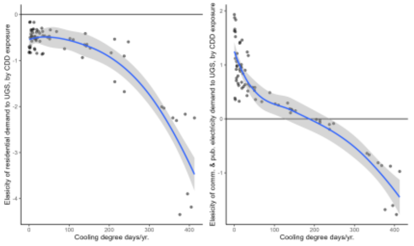
controlling for a set of time-variant factors (Z_{it}) and location and time fixed effects (ξ_i, μ_t).

Results

In CS1 (Italian provinces), we find evidence that in the hotter Summer months there is significantly **increased peak electricity consumption in provinces with low UGS.**



In CS2 (OECD metropolitan areas), we find that **higher UGS decreases the impact of cumulative heat exposure on yearly electricity demand** in both the residential and the commercial and public sectors.



Implications

On average a one percentage point increase in the UGS of metropolitan areas **reduces heat exposure-related electricity consumption** by 0.5% in the **residential** sector and 0.4% in the **commercial and public** sector → responses are heterogeneous and non-linear: strong dependance on the heat exposure intensity.

The high-frequency analysis in Italy demonstrates how **UGS reduces by up to 20% the increase in the peak electricity demand** in periods of the years and locations with high Tmax.

Prospects

- Use the derived empirical relations to establish what is the **global potential to expand UGS to reduce energy use** (and therefore emissions) in cities

- Evaluate if there a mitigation-adaptation **synergy** from UGS expansion in world cities

References

Li et al. (2023) Global Inequality in Cooling from Urban Green Spaces and its Climate Change Adaptation Potential. Preprint on arXiv

Falchetta and Hammad (2024) Tracking green space along streets of world cities. Preprint on ResearchSquare

Note: I have another simultaneous poster ☹

If I am not here, please find me at **Hall X4 | X4.157** or drop me an email to giacomo.falchetta@cmcc.it