Green Roofs as Climate Solutions: Building Thermal Regulation

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Introduction

This study evaluates the environmental benefits of **vegetated, or "green," roofing** using data from residential buildings in Quito, Ecuador. Green roofs are plant-covered surfaces that replace standard roofing materials and have been shown to **influence building temperature**, rainwater runoff, and other indicators of environmental impact[1,2,3]. Metropolitan cities, like New York City, are major real estate development hubs and contribute meaningfully to **global climate trends.**

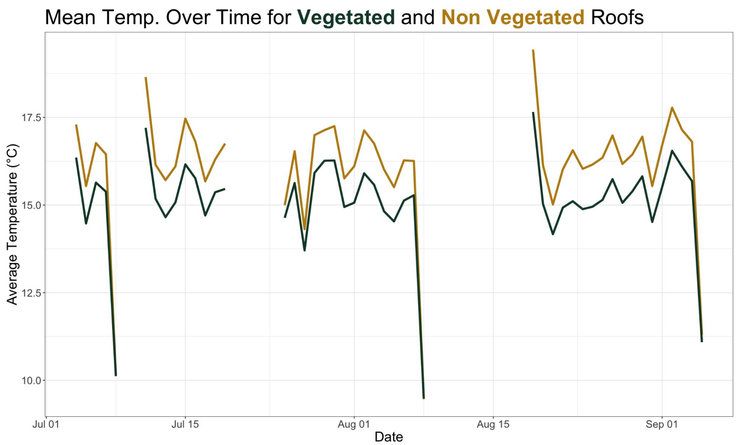

Figure 1

Methods

- Created descriptive visualizations to identify overarching themes/trends *(Figure 1)*.
- Compared cross-validated results of various **regression** approaches (OLS, penalized LS, KNN).
- Fit models to predict temperature based on the presence of a green roof, adjusting for time of day, month, humidity, and measurement group.
- **K-nearest neighbors** (k = 9; R^2 = 0.96, RMSE = 1.05) demonstrated superior performance to alternate regression methods (R^2 = 0.80, RMSE = 2.32).

Results

Across varying humidity levels, buildings in Ecuador with green roofs are cooler than those without, adjusting for month and time of day *(Figure 2)*.

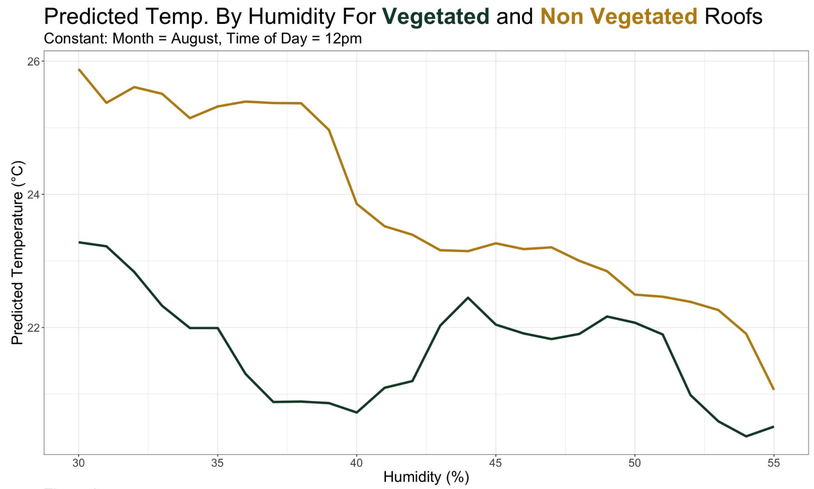

Figure 2

Discussion

- Cities with temperate climates similar to Quito may **improve their sustainability** with the implementation of green roofs.
- Since **green roofs reduce temperatures** in residential buildings, they may have a similar impact for commercial buildings in similar climates.
- Cooler temperatures **reduce the demand on HVAC and energy usage**, supporting climate goals by improving energy efficiency.
- The **number of buildings with green roofs has increased** in New York City at a higher rate in the last two decades *(Figure 3)*.
- The faster adoption of green roofs suggests growing recognition of their benefits; If New York City continues on this trajectory, it could help them attain **citywide sustainability goals**.

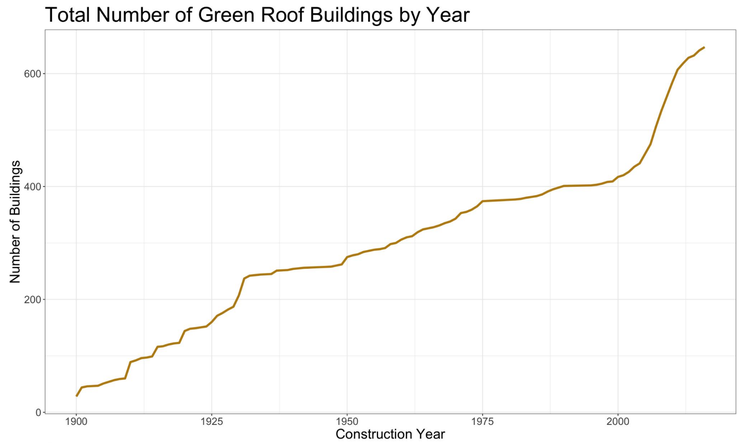

Figure 3

Next Steps

- The temperature data only includes **residential buildings**. Additional research should be conducted in metropolitan and commercial settings.
- These studies should **include other latent variables** to adjust for in future models (e.g. daily temperature, weather conditions).
- Future studies should also investigate whether green roofs are effective in **more extreme climates**.

References

1: United States Environmental Protection Agency. "Estimating the environmental effects of green roofs: A case study in Kansas City, Missouri." EPA, August 2018, https://www.epa.gov/sites/default/files/2018-09/documents/greenroofs_casestudy_kansascity.pdf.
2: United States Environmental Protection Agency. "Using Green Roofs to Reduce Heat Islands | US EPA." EPA, 2 April 2025, https://www.epa.gov/heatislands/using-green-roofs-reduce-heat-islands.
3: Glass, Charles C., and ETEC L.L.C. Green Roof Water Quality and Quantity Monitoring. 26 July 2007. American Society of Landscape Architects, https://www.asla.org/uploadedFiles/CMS/Green_Roof/Green_Roof_Water_Monitoring_Report.pdf.