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Improving indoor thermal comfort, air quality and the health of older adults through environmental policies in London

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Abstract. In this work we evaluate the potential of selected environmental strategies in reducing air pollution and summertime indoor overheating. Associated changes in mortality rates are also calculated for older adults in London. Reducing these risks for vulnerable groups is an immediate priority and given that seniors spend most of their time indoors, our focus is on strategies that prioritize the transformation of residential environments for indoor thermal comfort and air quality improvements. For each strategy, we develop specific scenarios related to building adaptations and test potential reductions on indoor overheating and pollutant exposures from outdoor sources ($PM_{2.5}$), as well as on senior mortality through the CRAFT tool (Cities Rapid Assessment Framework for Transformation). We then pick the scenarios with highest impacts on mortality, aiming to formulate effective policy recommendations for Greater London. Preliminary results suggest that environmental policies related to the installation of shading could have the highest reduction in heat and pollution-related senior mortality, followed by moderate effects due to building insulation retrofits and the greening of roofs. With an increasing ageing population in the UK and beyond, our work highlights the need for city-level policies to address building modifications, considering the importance of indoor spaces for older adults.

1. Introduction

As the impacts of climate change accelerate and with more than half of the world's population now living in cities [1], local governments are progressively adopting action plans to protect their populations and infrastructure and ensure a healthy and sustainable urban living [2]. To that end, London, UK has introduced a series of environmental strategies that aim at reducing among others, overheating and air pollution [3]. Minimizing these risks and associated health impacts for vulnerable groups, such as older adults, calls for a focus on residential environments, given that people and especially seniors in the UK spend more than 85% of their time indoors [4], which is further exacerbated by mobility restrictions posed to the population during the COVID-19 pandemic. Therefore, in this study, we aim to:

- review selected environmental strategies for Greater London and identify proposals that address dwelling modifications for improved thermal comfort and air quality, and consequently human health,

- develop and test specific scenarios corresponding to each proposal, in order to estimate potential impacts on summertime indoor overheating, indoor particulate matter ($PM_{2.5}$) exposure from outdoor sources and reductions in senior (>65) mortality, and
- formulate concrete and realistic policy recommendations for Greater London, based on the scenarios that yield highest impacts on mortality.

2. Method

Our approach summarized in Figure 1 relies on a 3-step methodology that starts with a review of London's Environment Strategy [3], a key policy document published by the Greater London Authority in 2018 that sets a number of goals for environmental action related to air quality improvement, noise and energy reduction, and climate change mitigation and adaptation. We identify high-level proposals with broad suggestions for dwelling modifications that can help improve thermal comfort and indoor air quality (IAQ). For each proposal, we develop a number of specific scenarios and test potential reductions in exposures to indoor summertime overheating and $PM_{2.5}$ from outdoor sources, and associated senior mortality impact through the use of CRAFT (Cities Rapid Assessment Framework for Transformation), a health impact assessment (HIA) tool introduced in [5]. Based on the results of each scenario, we make suggestions for London's environmental policies to incorporate building adaptations.

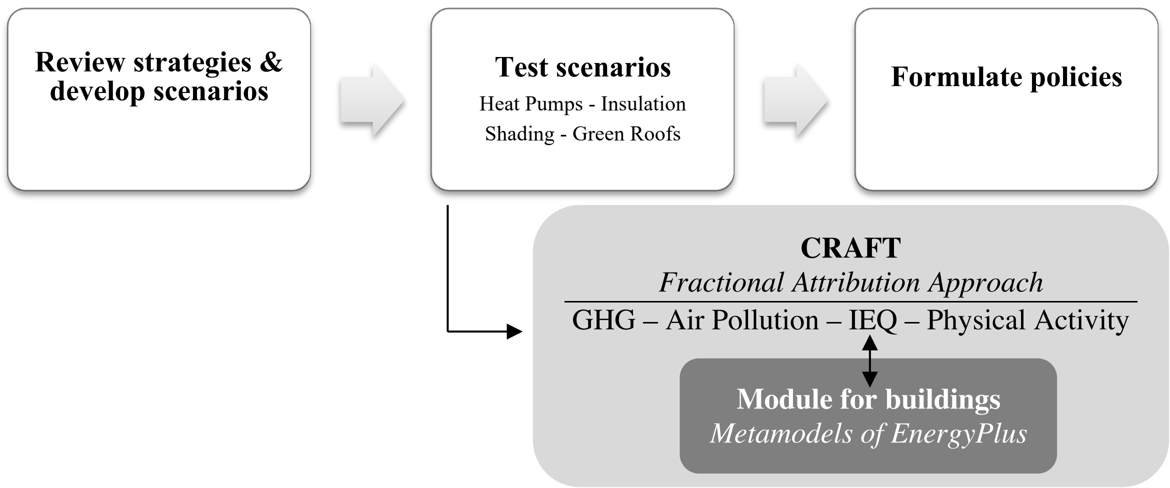

Figure 1: Flow diagram of methodology.

CRAFT is an Excel-based modeling framework, which was initially developed to provide broad estimates of impacts related to climate change mitigation and health of environmental policies for London. It is meant as a simple and rapid means to inform policy development at the early stages through calculating approximate changes in greenhouse gas (GHG) emissions, air pollution, indoor environmental quality (IEQ), and physical activity, as well as changes in associated mortality deriving from each policy. Each calculation is based on the attributable fraction approach, which generally includes multiplying the fraction of total emissions or exposure corresponding to a particular sector (e.g. housing, transport etc.) by the relative (fractional) change per sector unit due to each policy. Subsequently, an exposure-response function is used to estimate current attributable mortality due to a specific exposure or behavior, which is then compared to the modified mortality due to each policy. The CRAFT methodology relies on static linear calculations, and as such, it is intended to be combined with more detailed methodology of policy options at a later stage.

While CRAFT's existing focus is primarily on policies to improve health through reducing GHG emissions with co-benefits for exposure reductions, in the present study, we consider the expansion of the tool through the development of a new module for buildings. The module focuses on policies to improve health of older adults through testing the current and future effect of building adaptations on indoor thermal comfort and air quality. Ongoing work will utilize a metamodeling framework derived from simulations in EnergyPlus. This allows the prediction of indoor temperature and $PM_{2.5}$ in different archetypes of London's dwellings with and without building adaptation measures [6]. The baseline model uses the English Housing Survey (EHS) [7] to represent building characteristics for different archetypes, and resident age information. Once the effects of building adaptations for each archetype (bungalow, detached and semi-detached, mid- and-end terrace, converted, low- and high-rise flats) on indoor temperature and $PM_{2.5}$ are derived, the method follows CRAFT's fractional attribution approach for estimating impacts on indoor overheating and $PM_{2.5}$, as well as on reductions in mortality by age, including mortality of older adults for different age groups (65-74, 74-85 and 85+).

3. Preliminary Results and Conclusion

In our review of London Environment Strategy, we identified four proposals suggesting broad actions for dwellings, with the objective to mitigate heat, improve energy efficiency and reduce air pollution exposure. These include i) changes in the heating and cooling systems (i.e. heat pumps), ii) energy efficiency retrofits such as insulation, iii) solar shading and tree shading around homes, and iv) the promotion of cool and green roofs and walls. Several scenarios related to each proposal are currently being tested, specifying the type of adaptation for different building archetypes and the percentage of implementation over the total amount of dwellings. Health impact calculations also consider the number of older adults in different age groups. While scenario testing is still in progress, initial results suggest that the implementation of shading through external shutters could have the highest reduction on heat and pollution-related senior mortality, followed by the greening of roofs, while insulation retrofits could result in more moderate effects.

As the CRAFT module for buildings continues to develop, analysis will also estimate future (2050) impacts on indoor overheating, $PM_{2.5}$ and associated senior mortality, accounting for projected changes in the number of dwellings, increases in summertime temperatures due to climate change and demographic shifts. With roughly 25% of adults to be aged over 65 in the UK by 2050 [8] and with similar projections for large cities worldwide, our work suggests that HIA analysis and city-level policies should prioritize vulnerable populations and address building modifications, given the importance of indoor spaces for the population and especially for older adults.

References

[1] Bai, X., Dawson, R. J., Ürge-Vorsatz, D., Delgado, G. C., Barau, A. S., Dhakal, S., ... & Schultz, S. (2018). Six research priorities for cities and climate change.

[2] Phadke, R., Manning, C., & Burlager, S. (2015). Making it personal: Diversity and deliberation in climate adaptation planning. Climate Risk Management, 9, 62-76.

[3] Greater London Authority (GLA) (2018). London Environment Strategy. https://www.london.gov.uk/sites/default/files/london_environment_strategy_0.pdf

[4] Adams, S., & White, K. (2006). Older people, decent homes and fuel poverty: An analysis based on the English House Conditions Survey. *Help the Aged*.

[5] Symonds, P., Milner, J., Mohajeri, N., Aplin, J., Hale, J., Lloyd, S. J., ... & Davies, M. (2020). A tool for assessing the climate change mitigation and health impacts of environmental policies: the Cities Rapid Assessment Framework for Transformation (CRAFT). Wellcome Open Research, 5(269), 269.

[6] Taylor, J., Wilkinson, P., Picetti, R., Symonds, P., Heaviside, C., Macintyre, H. L., ... & Hutchinson, E. (2018). Comparison of built environment adaptations to heat exposure and mortality during hot weather, West Midlands region, UK. *Environment international*, *111*, 287-294.

[7] DCLG (2011). English Housing Survey 2010–2011. Department for Communities and Local Government: London, UK.

[8] NHS England (2019). Army of NHS experts brought in to care homes to tackle over-medication. Retrieved from: https://www.england.nhs.uk/2019/05/army-of-nhs-experts-to-tackle-over-medication/