Advancing Urban Sustainability: A Digital Spatial Assessment for Social Housing Environments in Bogotá, Colombia

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Declaration

I hereby declare that the contests and organization of this dissertation constitute my own original work and do not compromise in any way the rights of third parties, including those relating to the security of personal data.

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Abstract

Currently, more than half of the world's population lives in cities, and this is projected to increase to 60% by 2030. Urban sustainability has thus become an urgent global concern. Acute shocks such as the COVID-19 pandemic and the pressing effects of climate change have highlighted and exacerbated multidimensional inequalities within urban areas, posing significant challenges to sustainability transitions. These conditions disproportionately impact the most vulnerable populations, particularly in developing regions. To address these issues, this dissertation focuses on assessing the sustainability of social housing environments, which are typically designated for socioeconomically vulnerable communities. This research aims to support decision-making processes in the decarbonization and development of resilient, sustainable, safe, and inclusive urban areas through a comprehensive evaluation. To do so, the thesis follows a mixed-method approach that integrates quantitative approaches and spatial analysis with qualitative stakeholder involvement mechanisms. Bogotá, Colombia, has been selected as the case study for this evaluation, providing a relevant context within a developing country.

A systematic literature review has been conducted to examine the impacts of COVID-19 on urban sustainability highlights current trends and identifies research gaps, including the topic addressed in this thesis. This review remarks the urgent need for a comprehensive framework to evaluate and enhance the sustainability of social housing environments in developing cities. To address this topic it was initially developed a selection of indicators for evaluating urban sustainability in social housing environments, based on the criteria of local stakeholders. This selection process, conducted through a Delphi method, reflects the pressing needs of the city post-pandemic and resulted in a framework comprising 10 key performance indicators (KPIs) and 10 supporting indicators. This framework was subsequently applied in a digital spatial impact assessment to establish a baseline evaluation of sustainability conditions in Bogotá. This assessment reveals significant spatial disparities in livability conditions between areas with a high concentration of social housing and other parts of the city. Furthermore, a spatial disaggregation of greenhouse gas (GHG) emissions complements the sustainability assessment, employing an expanded Kaya identity to capture GHG emission scenarios with the same spatial granularity. This evaluation shows that residential areas with a higher presence of social housing exhibit low levels of emissions in

the city, in contrast to high-income residential areas, which present the highest emission levels. This analysis of GHG complements the previous spatial impact assessment and provides more representative conditions of the built environment, enabling the evaluation of targeted actions that promote climate justice.

Overall, this thesis contributes to the field of urban sustainability by providing a digital data-driven framework for assessing and improving urban sustainability conditions. It underscores the importance of integrating stakeholder perspectives and spatial analysis in sustainability assessments. However, limitations such as data quality and the dynamic nature of urban planning frameworks are acknowledged, indicating the need for continuous updates and refinements. This research offers valuable insights and practical tools for urban practitioners and policymakers to support decision-making in the transition toward sustainable and equitable urban environments. It also provides a foundation for future studies and policy interventions aimed at enhancing the sustainability and resilience of social housing environments in Bogotá and similar urban contexts worldwide.