Auditing Population Mapping Infrastructures in Four Global South Cities

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1 Introduction

Dynamic population mapping products derived from digital trace data are increasingly used in humanitarian response, crisis monitoring, epidemiological modelling, and urban governance because they capture near real-time and high-frequency information (Aydoğdu et al., 2025a; Oliver et al., 2020; Smallwood et al., 2022; Yabe et al., 2022). Unlike census-constrained products such as WorldPop, which redistribute administrative population counts using dasymetric modelling and ancillary spatial data, mobile-derived approaches estimate population distribution from observed digital activity and mobility patterns (Leyk et al., 2019). Despite their growing operational importance, limited attention has been given to how these fundamentally different population infrastructures allocate demographic weight across urban space, particularly in Global South cities where smartphone ownership, internet access, and digital participation remain uneven. Existing validation studies typically compare products within the same methodological family or against administrative benchmarks (Jia et al., 2020; Naushirvanov et al., 2025), often implicitly treating one dataset as reference truth. Less examined is how different population products may systematically redistribute representation across socio-economically unequal urban areas.

This study develops an allocation-sensitive audit framework to compare two widely used but methodologically distinct population products: WorldPop and Meta's *Population During Crisis* baseline. Rather than treating either product as ground truth, we conceptualise both as allocative infrastructures that produce different representations of urban populations. Across four Global South cities, Cagayan de Oro, Davao City, Nairobi, and Mexico City, we compare normalised population allocation across harmonised urban grid cells using concentration metrics, redistribution indices, and spatial error models. The analysis evaluates whether allocation differences between the two products are spatially uneven and whether divergence is associated with low-wealth urban areas. In doing so, the study contributes a comparative framework for auditing the socio-economic implications of dynamic population mapping products in humanitarian and governance applications.

2 Data and Methodology

To compare allocation independently of total population volume, datasets were normalised into intracity population shares ($p_i^d = x_i^d / \sum_j x_j^d$, where x_i^d is the pop-

Table 1. Cross-city summary of allocation divergence metrics.

City	N	Spearman ρ	ΔGini	ΔTop10	SEM τ	p
Cagayan de Oro	98	0.841	-0.001	-0.008	-0.02	0.902
Davao City	309	0.886	0.075	0.044	-0.11	0.031
Nairobi	234	0.763	0.022	0.028	-0.15	0.013
Mexico City	259	0.937	-0.009	0.004	0.05	0.309

Notes: Differences: Meta - WorldPop. SEM τ controls for distance and log density.

ulation assigned to grid cell i by dataset d). Agreement and divergence between datasets were then evaluated using correlation, concentration, and redistribution metrics, while spatial error models assessed whether allocation divergence is associated with low-wealth urban areas.

We compare two gridded population products across four Global South cities: WorldPop and Meta's *Population During Crisis* baseline. WorldPop is a census-constrained population product, whereas Meta derives population estimates from aggregated digital activity signals. Rather than treating either dataset as ground truth, the analysis examines how these distinct population infrastructures allocate demographic weight across urban space and whether their allocation differences align with socio-economic inequality.

All datasets were harmonised to a common coordinate reference system and aligned to an approximately 2.5 km grid. Analysis was conducted at the grid-cell level using cells with non-zero allocation in both datasets. Socio-economic context was incorporated using the Relative Wealth Index (RWI), with additional controls for urban centrality and density.

3 Preliminary Findings

Across all four cities, Meta and WorldPop exhibit strong spatial agreement (Spearman $\rho = 0.76$–0.94; Table 1). However, high agreement does not imply equivalent allocation structure. Davao City and Nairobi show greater concentration in the Meta-derived surface relative to WorldPop (ΔGini > 0), alongside significant negative wealth-associated allocation effects (SEM $\tau = -0.11$ and -0.15, respectively). By contrast, Cagayan de Oro and Mexico City exhibit near-parity in concentration metrics and no statistically significant socio-economic divergence. These findings suggest that strong aggregate correspondence between gridded population products can coexist with meaningful socio-spatial redistribution differences, particularly in lower-wealth urban areas.

Keywords: Dynamic population mapping · gridded population datasets · allocative infrastructures · spatial inequality · representational bias · Global South