Summary

This manuscript presents a highly significant and methodologically rigorous study. The authors have successfully developed a novel, scalable framework that integrates household surveys, multi-spectral satellite imagery, and gridded population data to produce the first spatially explicit, gridded inventory of slum populations across 129 Global South countries. The hybrid machine learning approach (ResNet-34 + XGBoost) is well-justified and state-of-the-art. The manuscript is well-structured, the validation is comprehensive, and the work addresses a critical data gap. It represents a substantial contribution to urban geography, sustainable development, and applied remote sensing. I recommend publication after the authors address the following points to further strengthen an already excellent manuscript.

Major Comments

1. **Lines 716-739 (Spatial Resolution & Policy Relevance):**

   The technical rationale for the 6.72 km resolution is clear. However, the discussion would benefit from a more explicit analysis of its **policy and practical implications**. Please briefly elaborate on what scale of planning or analysis (e.g., national/regional resource allocation, identifying broad vulnerability hotspots) this product is optimally designed for, and contrast this with applications for which it is *not* suitable (e.g., intra-city infrastructure planning). This will greatly aid end-users in correctly applying your dataset.

2. **Lines 365-370 & 192-201 (Population Data Processing - Critical Clarification):**

   In Section 3.4, you mention resampling the GHS-POP data using "cubic convolution." For population **counts** (as opposed to density), the standard and conceptually correct method for aggregation to a coarser resolution is **summation**, which preserves the total population. Please explicitly clarify:

   - Was the cubic convolution applied to a population *density* layer?
   - If it was applied to counts, please justify this methodological choice in Sections 2.3 or 3.4 and discuss its potential impact on the final slum population totals.

3. **Lines 807-817 (Quantifying the "Equal Household Size" Assumption):**

   You correctly identify this as a key limitation and provide helpful data from India. To strengthen this discussion, I strongly recommend adding a **simple sensitivity or bounding analysis** (e.g., in the Supplementary Materials). Providing a quantitative

estimate (e.g., "If slum households were, on average, 10% larger, our national estimate for Country X would change by approximately Y%") would powerfully contextualize the potential magnitude of bias introduced by this assumption.

4. **Lines 648-651 (Characterizing Uncertainty for Data-Scarce Regions):**

Your note on countries where estimates may be less reliable is important. To enhance transparency and guide future work, please consider:

   - **Listing or mapping these specific countries** in the Supplementary Materials.
   - Briefly suggesting how future model iterations might reduce this uncertainty (e.g., incorporating spatial context or other proxy data).

5. **Lines 767-831 & 845-863 (Connecting Results to Actionable Research & Monitoring):**

The implications are well-discussed. Please consider extending this slightly to propose **1-2 concrete, actionable research pathways** directly enabled by this new dataset (e.g., integration with commensurate-scale climate hazard maps for compound risk assessment). Furthermore, in the Conclusion, you could more forcefully frame this work not just as a static map, but as the **foundation for a future monitoring system**, highlighting its readiness for updates with new DHS and satellite data (e.g., Landsat Next, Sentinel-2).

Minor Comments

- **Formatting Consistency:** Please ensure consistent formatting of references and acronyms throughout (e.g., "UN-Habitat" vs. "UN-Habitat" in Lines 49, 225).
- **Lines 233-245 (Clarifying the Slum Indicator Formula):** Adding a one-sentence intuitive explanation of the formula in the text (e.g., "The indicator calculates a weighted average of the proportion of households lacking services in each dimension") would improve readability for a broader audience.
- **Typographical Errors:** A final proofread is recommended to catch minor errors (e.g., "grided" should be "gridded" in Lines 125, 850).