

**Atlas AI**

# A Comparison of the Atlas of Human Settlements against the Global Human Settlement Layer

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## Atlas of Human Settlements

AHS is the first commercial grade built-up basemap of the world!

- **coverage:** global extent
- **resolution:** 10m
- **updates:** annually, semi-, quarterly or monthly,
- **historical records:** since 2016

Primary data layers:

- **Built-up Index or BuI:** reports the percentage of built surface within a spatial unit of  $100 \text{ m}^2$ .
- **Built-up Confidence or BuC:** reports the confidence of the regressor in producing the BuI value for each input pixel.

**Technology:** Generated using a state-of-the-art AI model implemented on a U-Net-like, multi-scale convolutional attention encoder to transformer-decoder architecture using multi-scale attention.

## Global Human Settlement Layer

GHSL: non-commercial alternative to the AHS. Offered by the JRC of the European Commission.

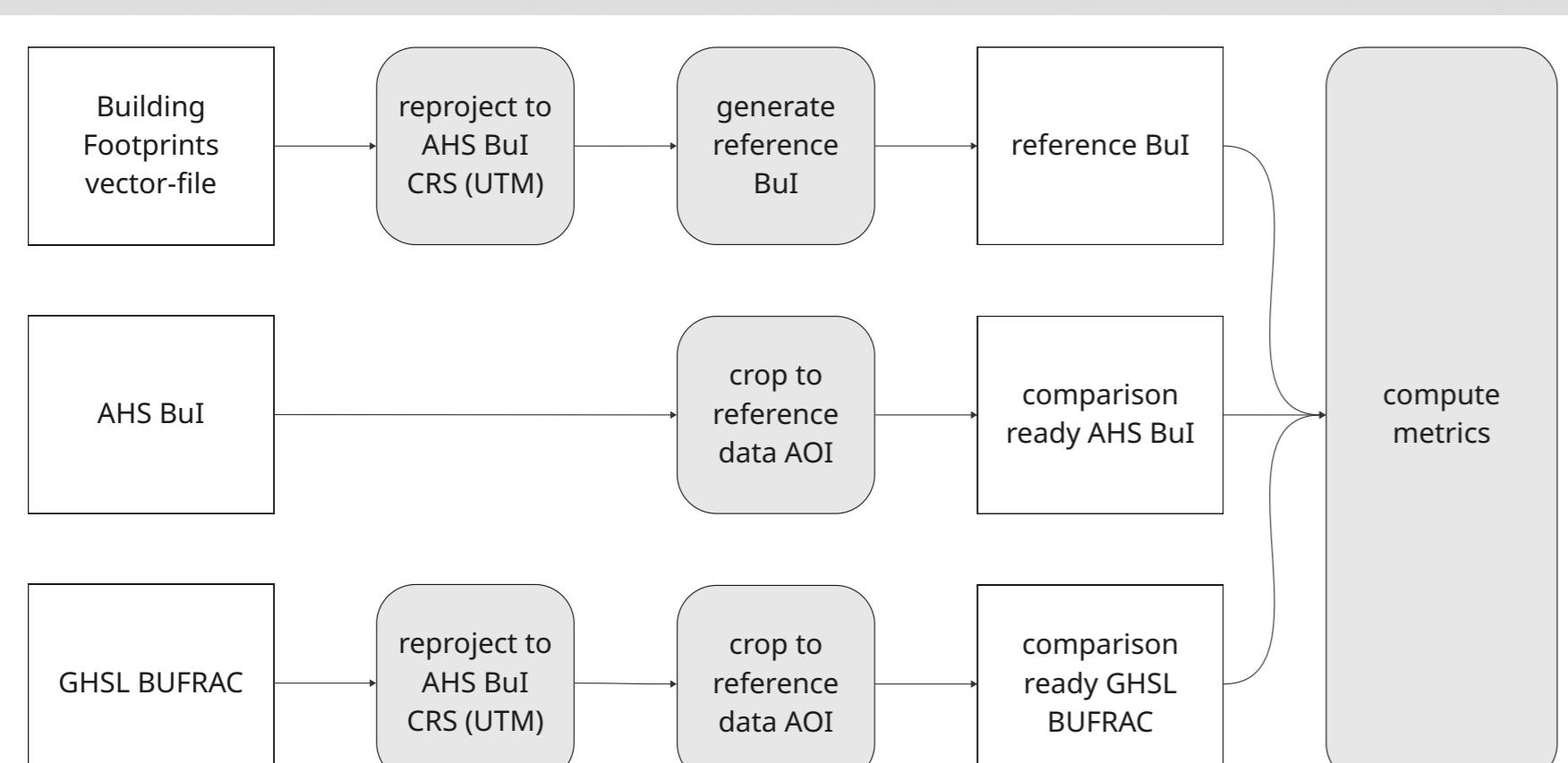
- **coverage:** global extent
- **resolution:** 10m
- **updates:** none, 2018 epoch, R2023 release
- **historical records:** none

Primary data layers:

- **Built-up Fraction or BUFRAC:** reports percentage of built surface within a spatial unit of  $100 \text{ m}^2$ .

**Technology:** Generated using Symbolic Machine Learning, a model-free image classification algorithm.

## Figure 1: Evaluation Workflow



Both inferred layers are from the same 2018 annual (median) composite. Building footprints are mostly from dates near 2018.

## Qualitative Analysis

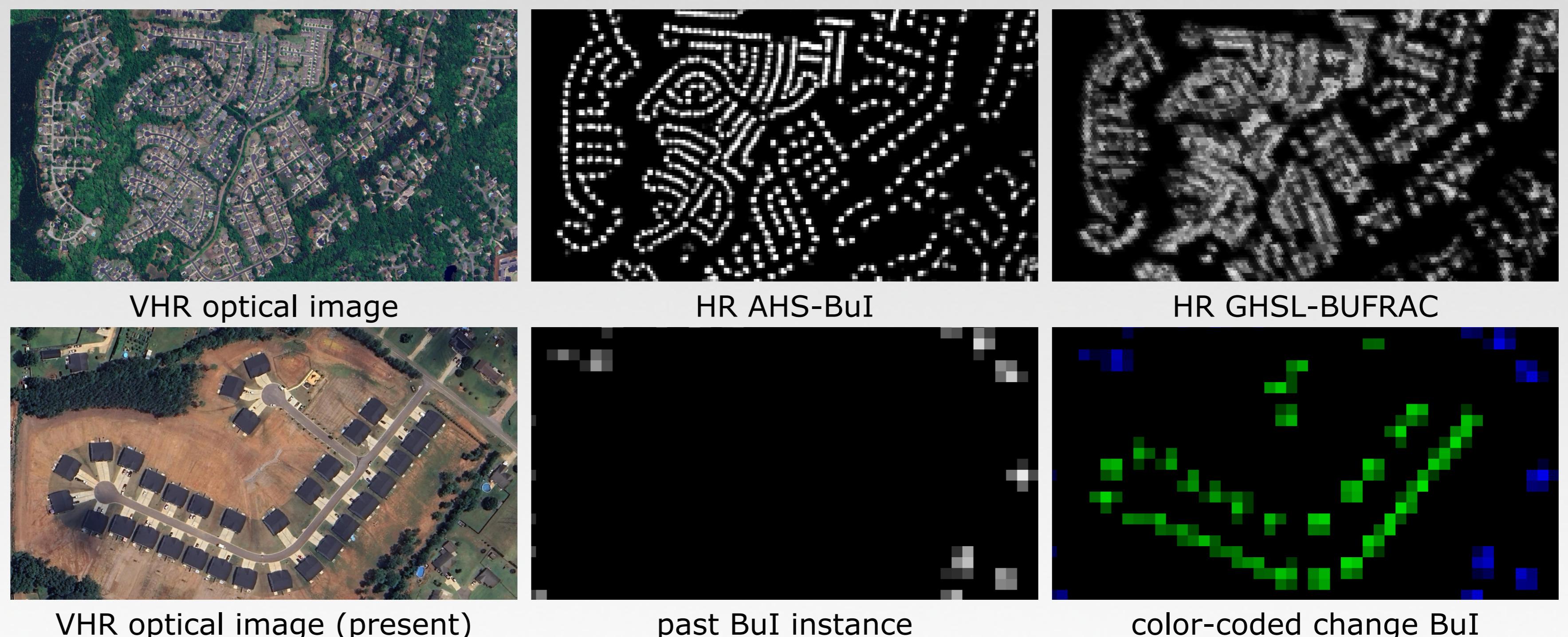
Geospatial data-scientists evaluating:

- built-up surface completeness - Fig.2 - top
- noise in-between built-up - Fig.2 - top
- noise outside settlements
- visual clarity of built-up- Fig.2 - top
- quality of big building segmentation - Fig.3
- suitability for computing built-up statistics
- suitability for change detection - Fig.2 - bottom

## Quantitative Analysis

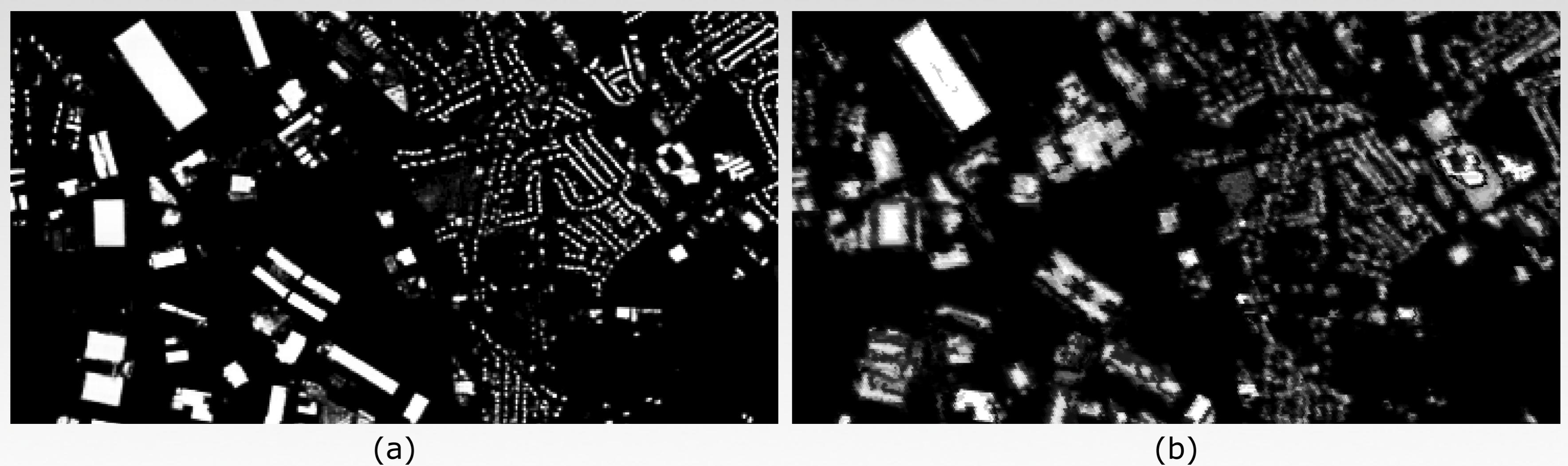
- 8 AOIs in 6 different countries: China - Jinxiang, Japan - Hamamatsu, Japan - Kyoto, Japan - Mae-bashi, Poland - Warsaw, South Africa - Cape Town, UK - Southampton, USA - Worcester (MA).
- Manually delineated BFPs were converted to Test Surfaces (BuI-equivalent)
- compute the closeness of each layer against the test surfaces using:
  - for surface comparison: **binary accuracy**, **precision**, **recall**, **F1 score** and **Matthew's Correlation Coefficient**
  - for regression outputs: **Round Mean Square Error** and **Mean Average Error**

## Figure 2: AHS vs GHSL Inference and Change Detection



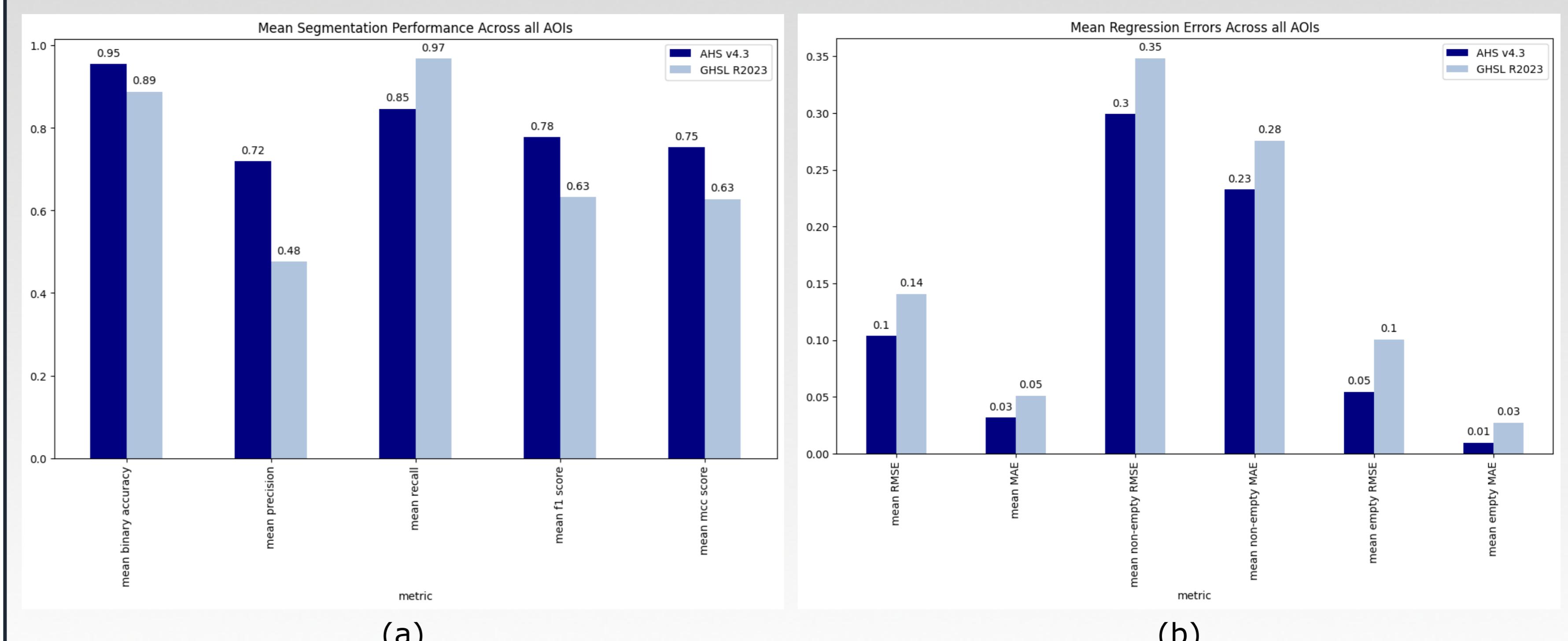
Top row from left: an RGB view of a residential neighborhood in GE-USA; the AHS-BuI layer and the GHSL-BUFRAC layer. Bottom row from left: an RGB view of a new construction project; the AHS-BuI layer from the past time stamp; the color-coded change BuI between the past and present time stamps (green: new built-up, blue: unchanged)

## Figure 3: Commercial Buildings



Big building inference in AHS (a), and GHSL (b). In (a) they are easy to segment and clearly distinguishable. In (b) they are mostly blurry, inter-connected with /corrupted by noise.

## Figure 4: Results - Quantitative Analysis



Averaged metrics across all 8 AOIs for both the AHS and the GHSL; built-up segmentation in (a) and built-up regression in (b). Empty chips do not contain any built-up in the test-surfaces.

## Summary of Findings

feature	AHS	GHSL
built-up surface completeness	good	good
noise in-between built-up	minor	fair
noise outside settlements	minor	minor
visual clarity of built-up	crisp	poor
big building segmentation	crisp	poor
built-up statistics	yes	somewhat
change detection	yes	no

Table 1: Qualitative Analysis

feature	notes
segmentation	AHS leads GHSL in F1 and MCC scores by 14% and 13% respectively and consistently throughout all 8 AOIs. GHSL: Major imbalance between precision and recall
regression	AHS shows a relative reduction of about 30% in regards to RMSE and about 35% in regards to MAE when compared to the GHSL. Persistence in empty ( $\text{BuI}=0$ ) and non-empty ( $\text{BuI}>0$ ) pixel sets too.

Table 1: Quantitative Analysis

**Conclusion:** The comparison yields an overwhelming lead of the AHS over the GHSL!