

# Combining Satellite Imagery and Machine Learning to Predict Poverty

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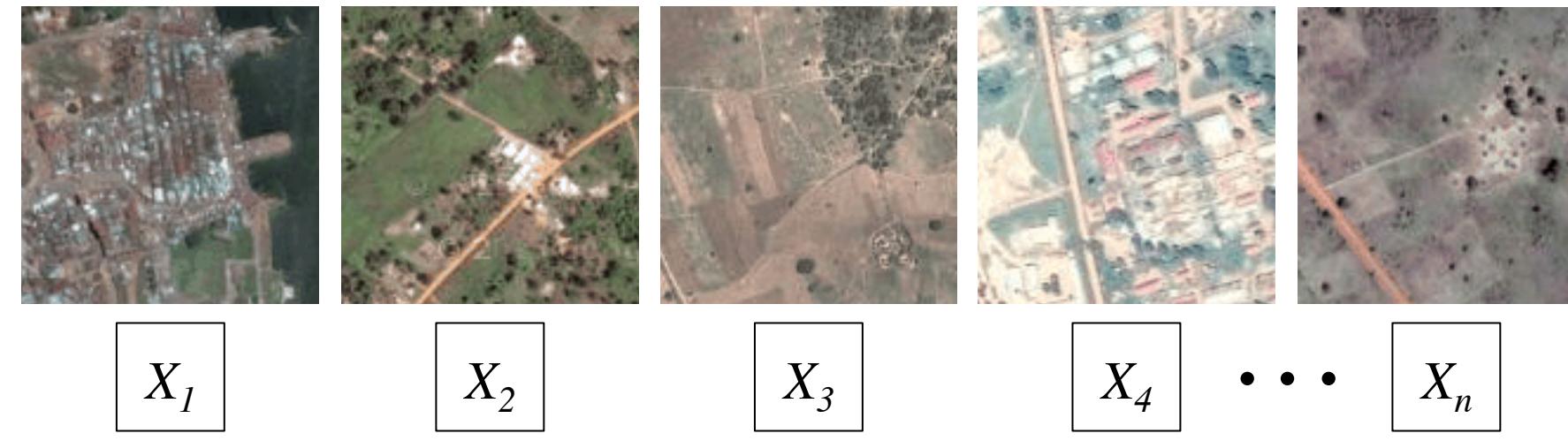
## Motivation

- Global poverty line: **\$1.90/person/day**
- Almost 1 billion people live in abject poverty
- Lack of reliable data in developing countries poses a major challenge for making informed policy decisions

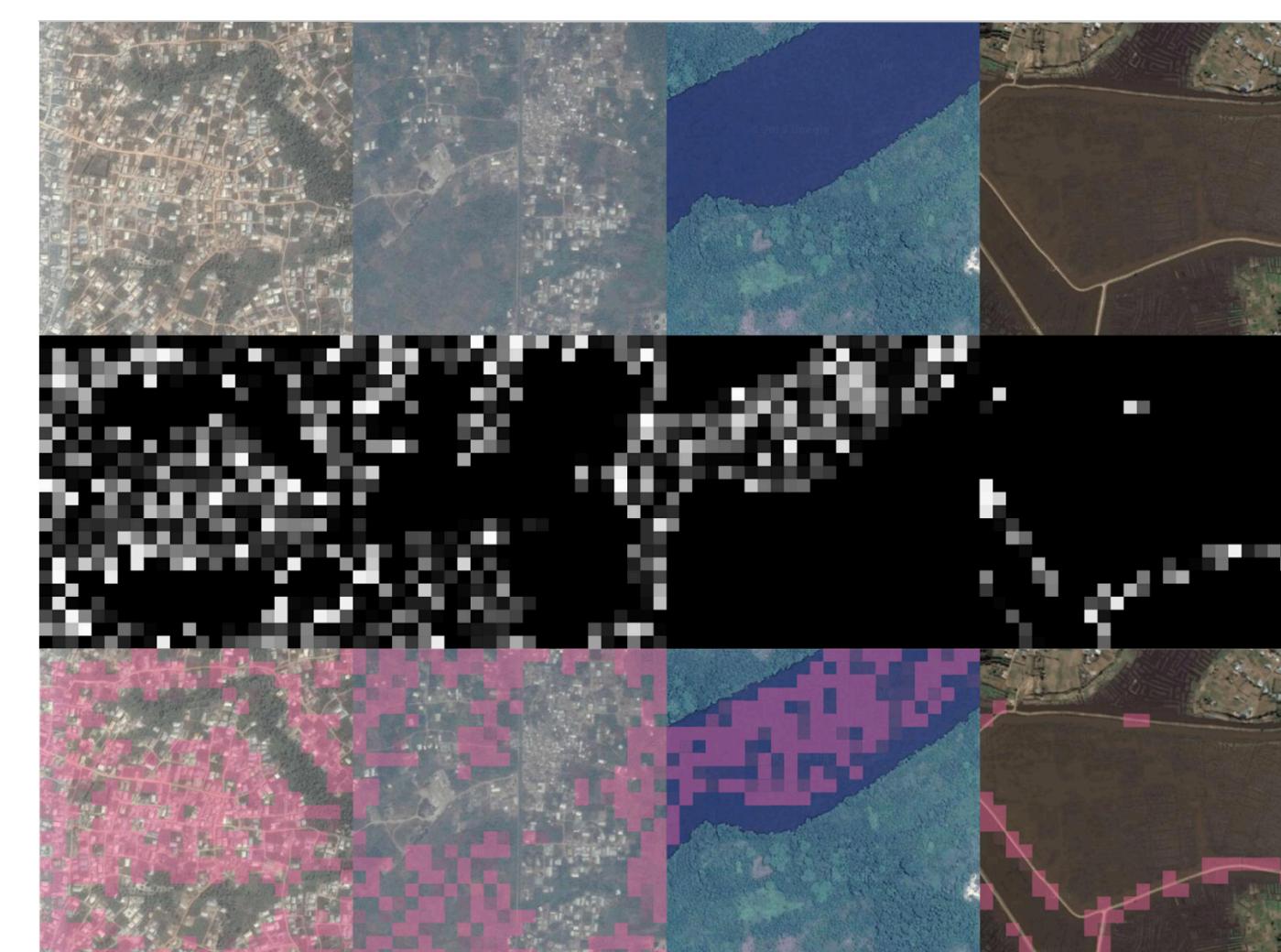
## High-level overview

- **Goal:** Accurately and scalably predict poverty and wealth measures from daytime satellite images, using only publicly available data

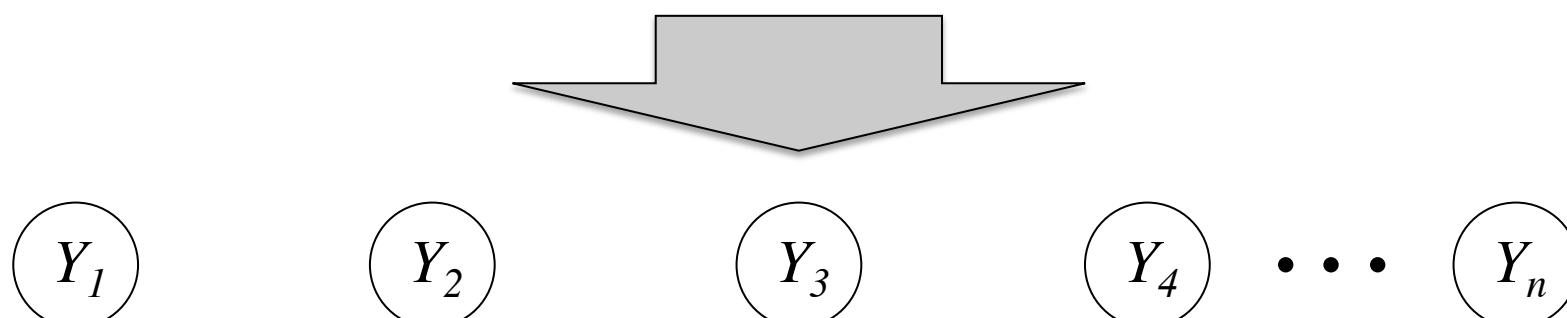
## Inputs: Daytime satellite imagery



## Convolutional Neural Network



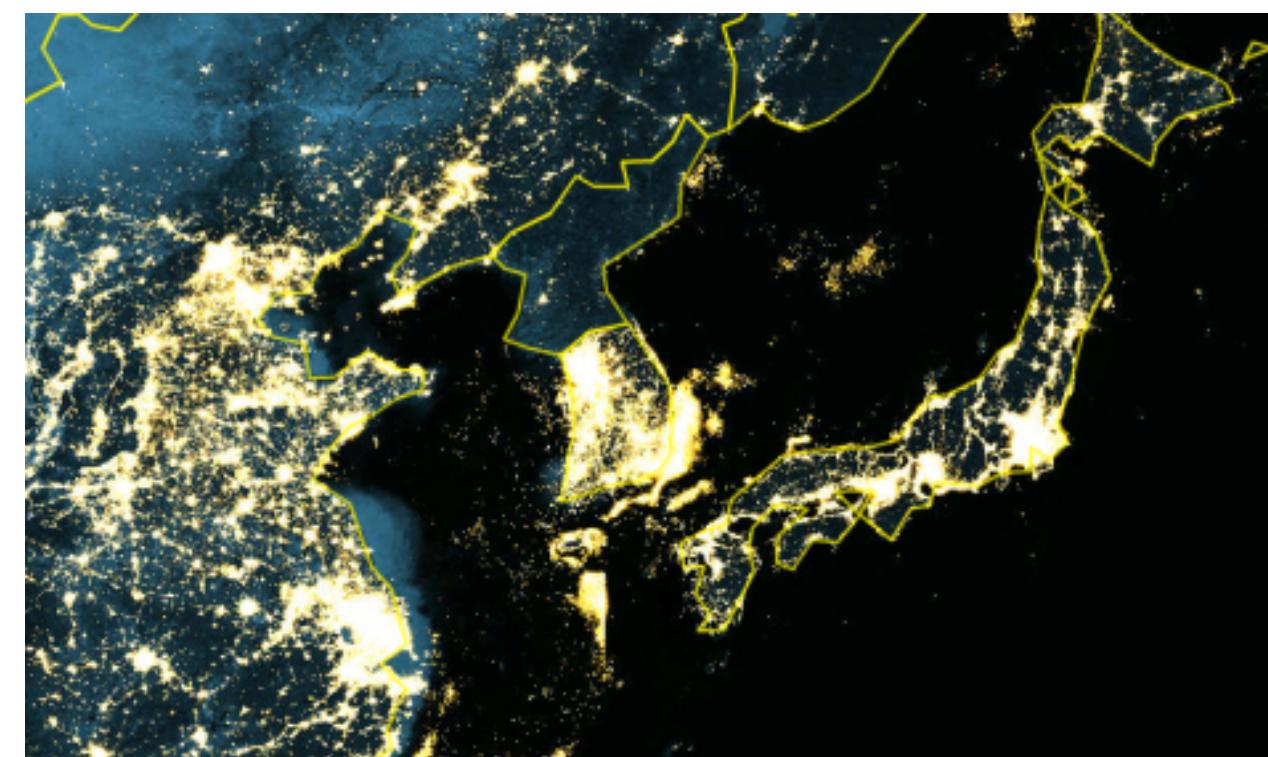
## Low-dimensional feature representation



## Predictions: Economic indicators

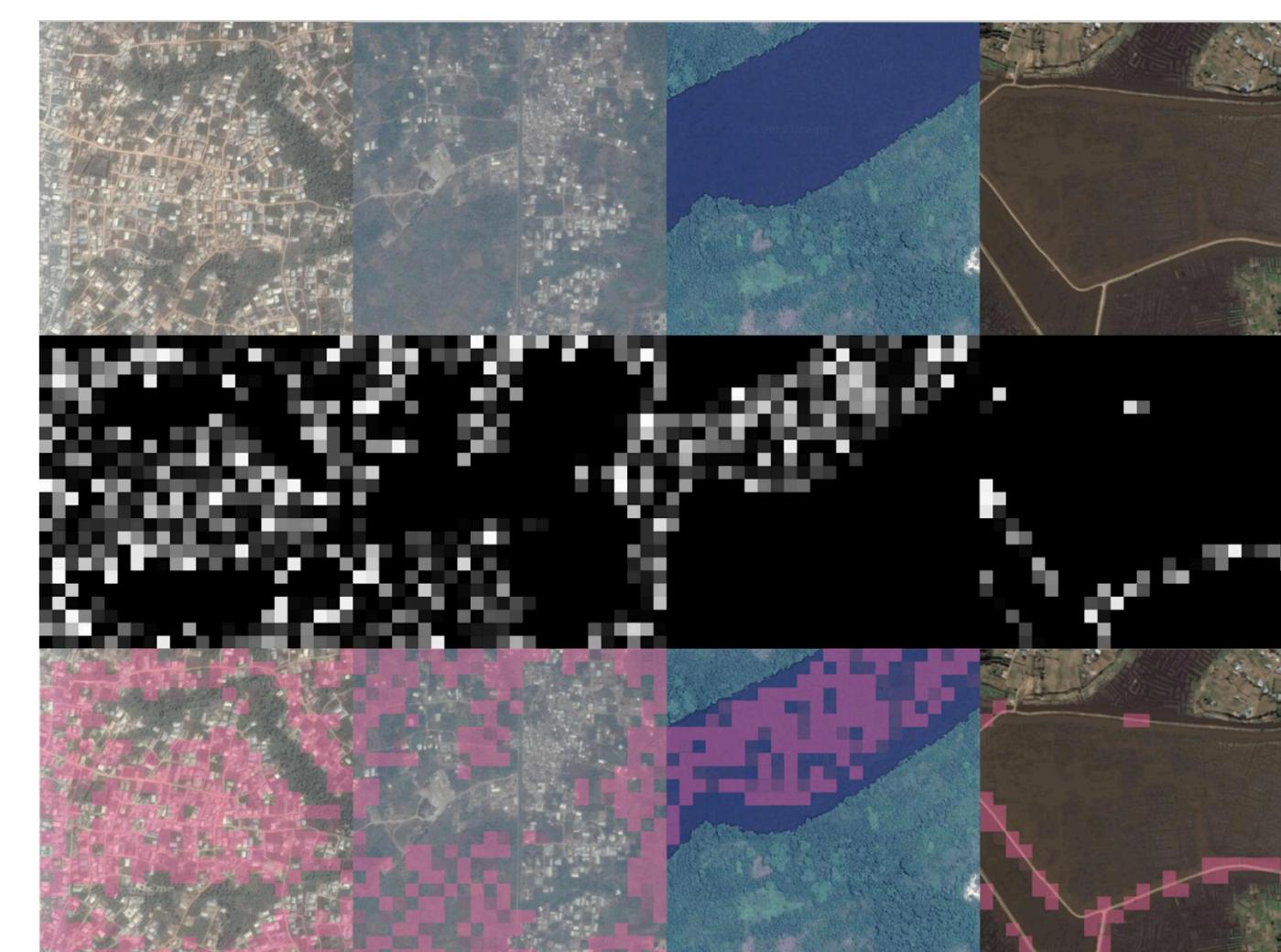
## Transfer learning approach

- Standard supervised learning won't work—there isn't enough ground truth poverty data
- **Key idea:** Use nighttime light intensity as a proxy for economic development



North Korea vs. South Korea

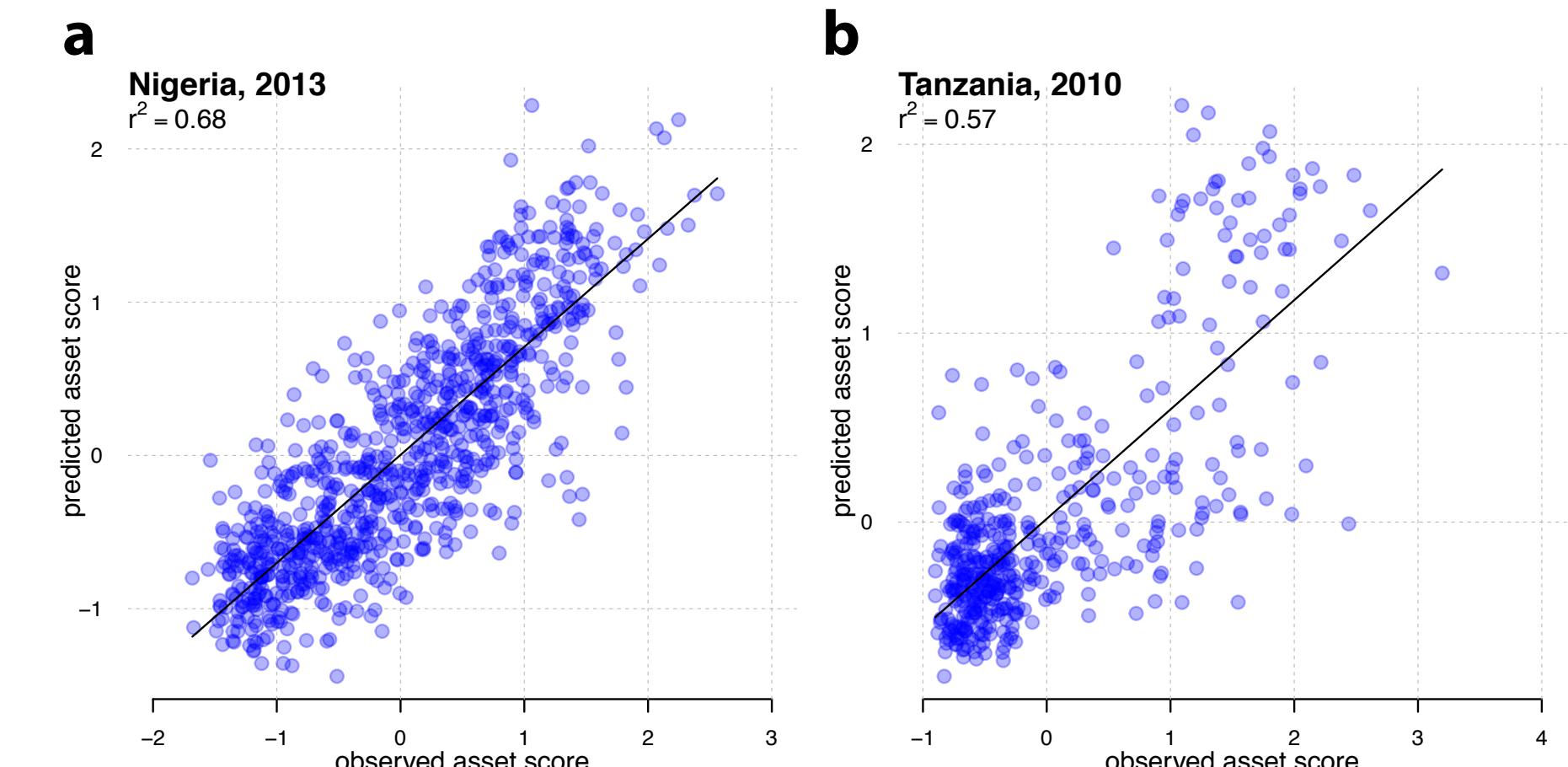
- Train a convolutional neural network (CNN) to extract image features relevant to nighttime lights
- A subset of these features are also useful for predicting economic well-being



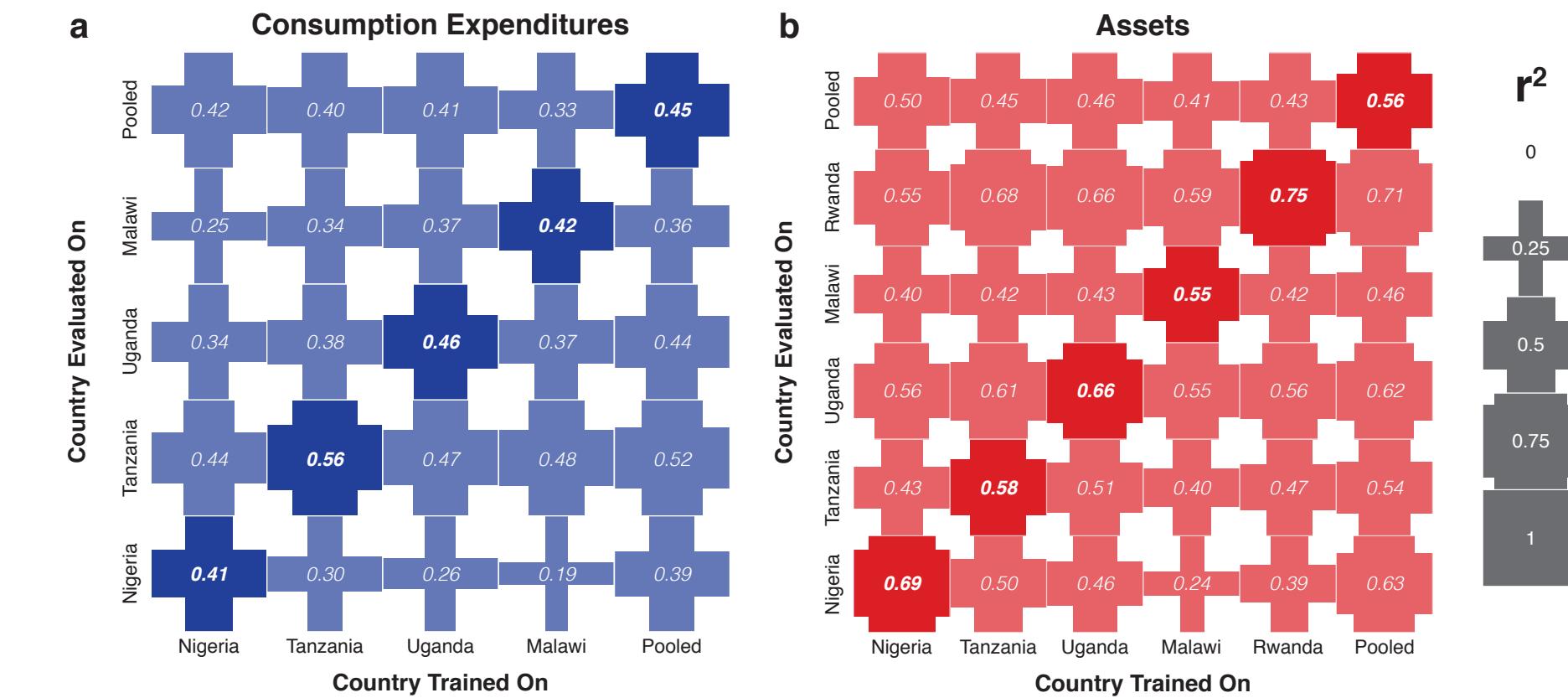
Learned features corresponding to buildings, undeveloped areas, water, and roads

## Results

- **Task:** Predict consumption expenditures and asset wealth in 5 African countries



Asset-based wealth predictions for (a) Nigeria and (b) Tanzania



Cross-border generalization for (a) expenditure and (b) asset models

- Accuracy compares favorably with recent study in *Science* that uses mobile phone data to predict poverty
- Models generalize well across borders, suggesting that satellite imagery reveals shared features of poverty

## References

- [1] C. Elvidge, K. Baugh, et al. *Proceedings of the Asia-Pacific Advanced Network*, 2013.
- [2] J. Blumenstock, G. Cadamuro, and R. On, *Science* **350**, 6264 (2015).
- [3] M. Xie, N. Jean, et al. *CoRR 1510.00098* (2015), <http://arxiv.org/abs/1510.00098>.