

Combining Aerial Photography and Machine Learning to Map 20th Century African Urban Change

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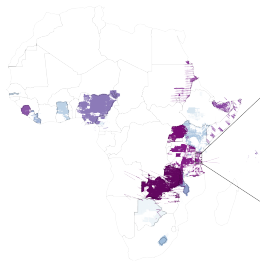
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Understanding 20th Century Urbanization for 21st Century Policy

- African cities will grow dramatically this century
- Investments today have enormous implications for future welfare
- Urbanization is a fundamentally long-run process
- A lack of historical data constrains our understanding of historical urbanization

Using Remote Sensing to Study 20th Century Urbanization

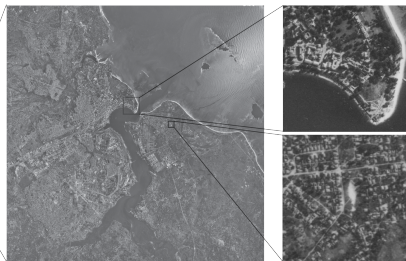
17 countries, 1.1 M images



Eastern Tanzania, 1981, 258 images

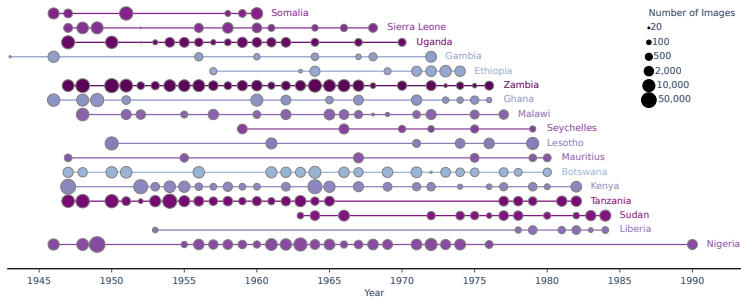
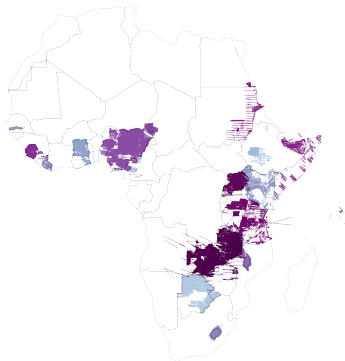


Dar es Salaam, 1981



- How might advancements in modern earth observation help us understand the past?
 - > 160 M images, 65 archives back to mid-19th Century (Masson et al., 2025)
- This project: Studying historical urbanization using aerial imagery and deep learning

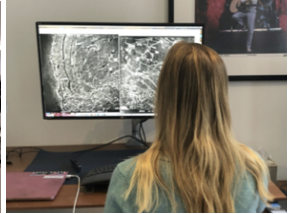
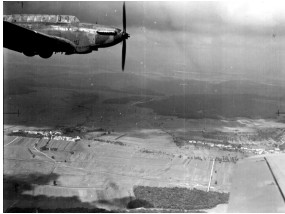
Extending the Record





Kibera, Nairobi, Kenya, in 1948 (left) and 2025 (right)

The Aerial History Project



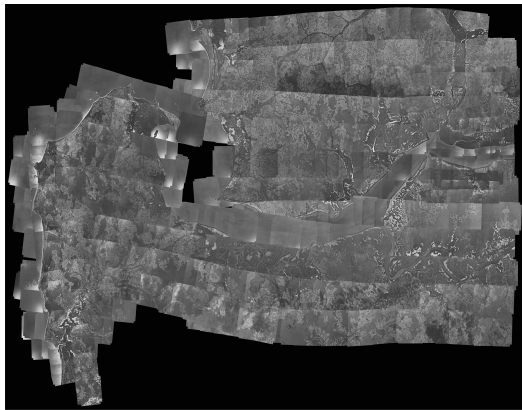
The Aerial History Project



1. Digitize 1.7 million raw images

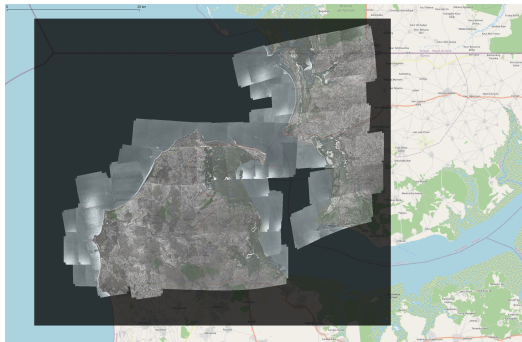
The Aerial History Project

1. Digitize 1.7 million raw images (Masson et al., 2025)
2. Stitch images into mosaics (Noda et al., 2024)
3. Georeferenced images (Noda et al., 2024)
4. Machine learning predictions



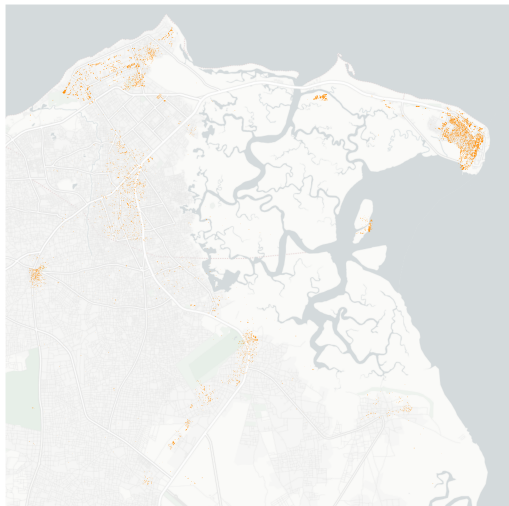
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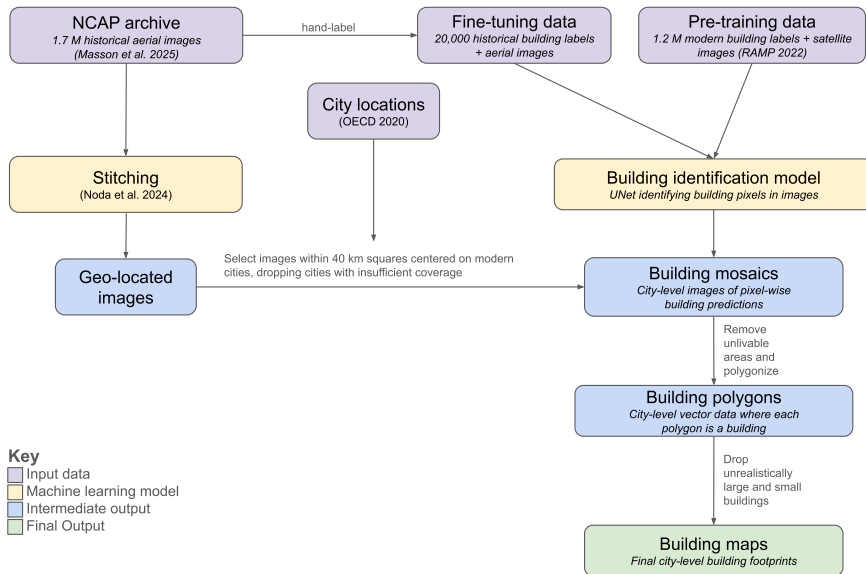


The Aerial History Project

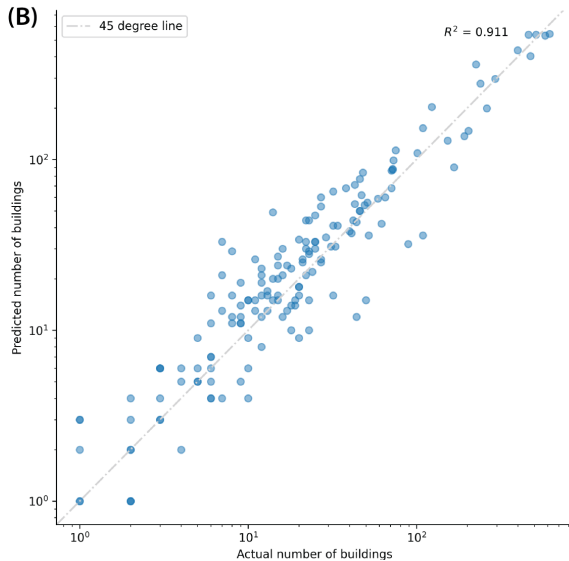
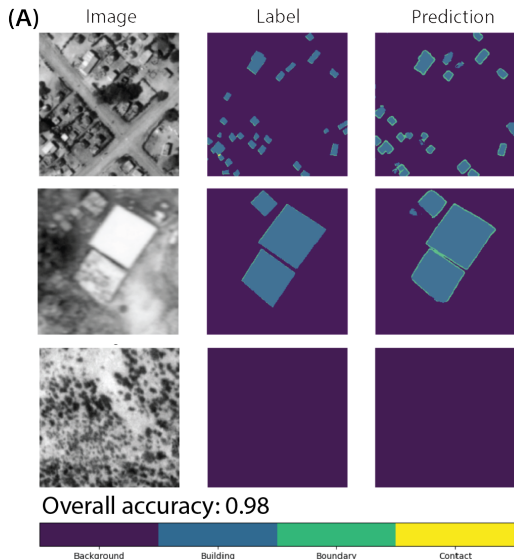
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4. Machine learning predictions
 - Buildings (this project)
 - Land use (Murayama et al., in prep.)
 - Wealth and population (Ferguson et al., in prep.)



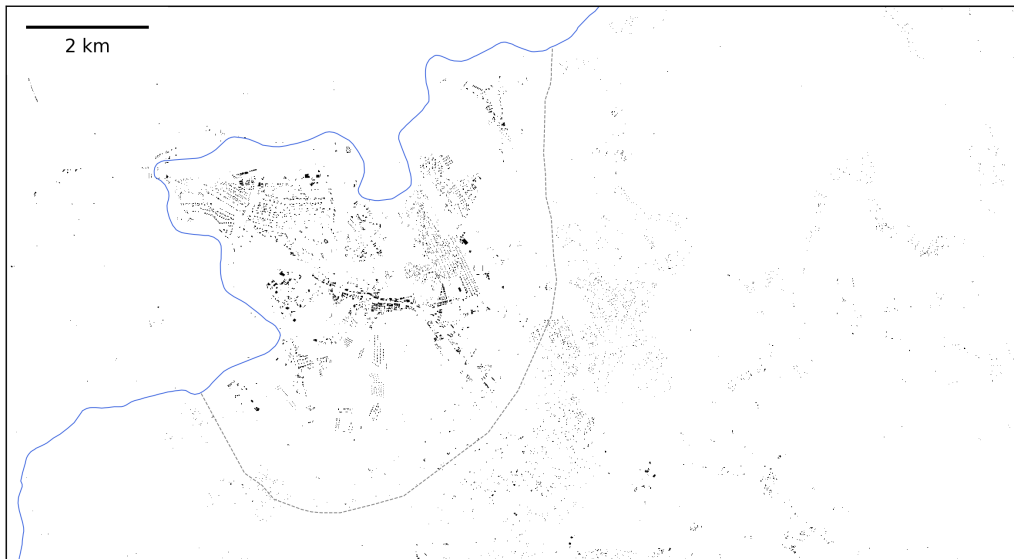
Historical building detection pipeline



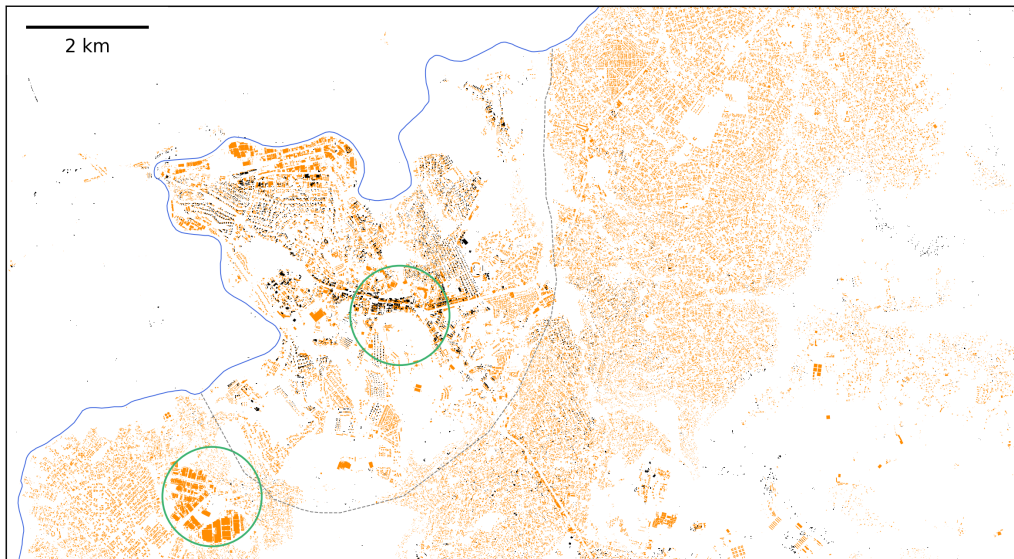
Model Performance



Maseru, Lesotho, 1974

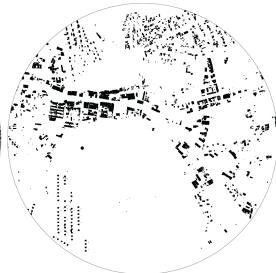


Maseru, Lesotho, 1974 and 2018



CBD

1974

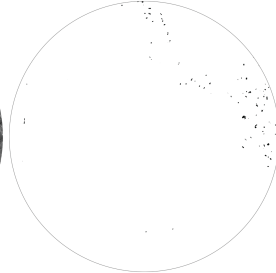
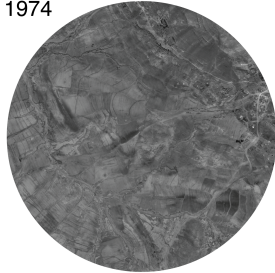


2018

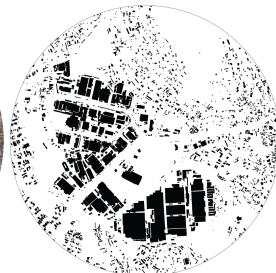


Thetsane

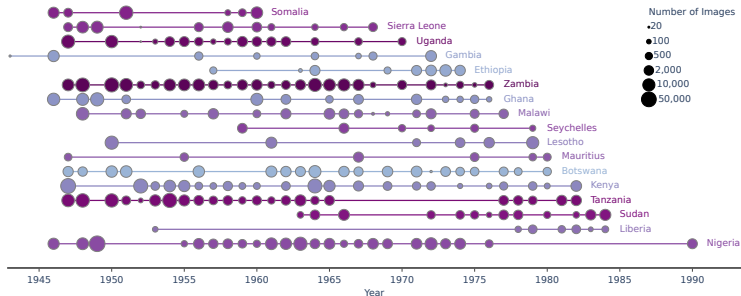
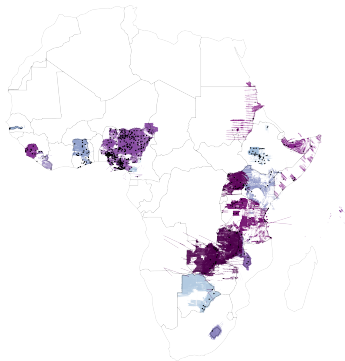
1974



2018

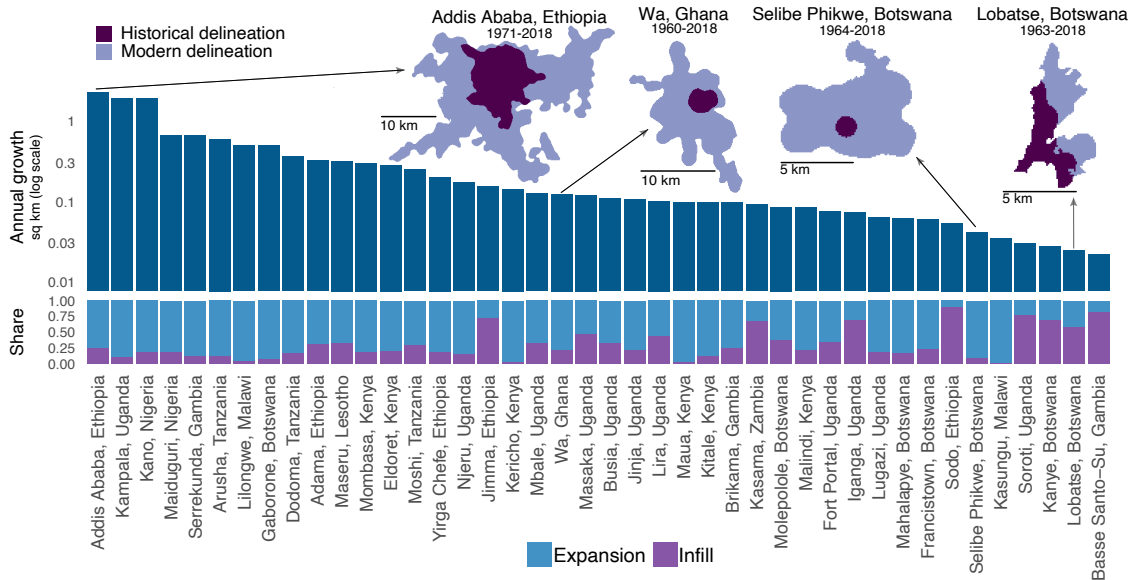


581 Building Maps, 1943-1990

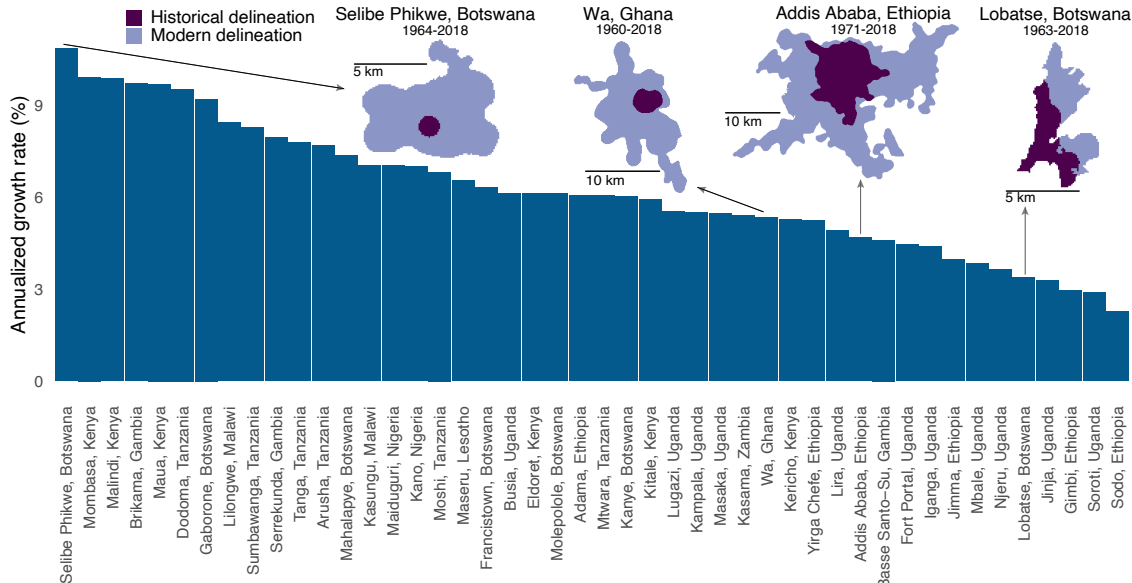


Today: 42 examples

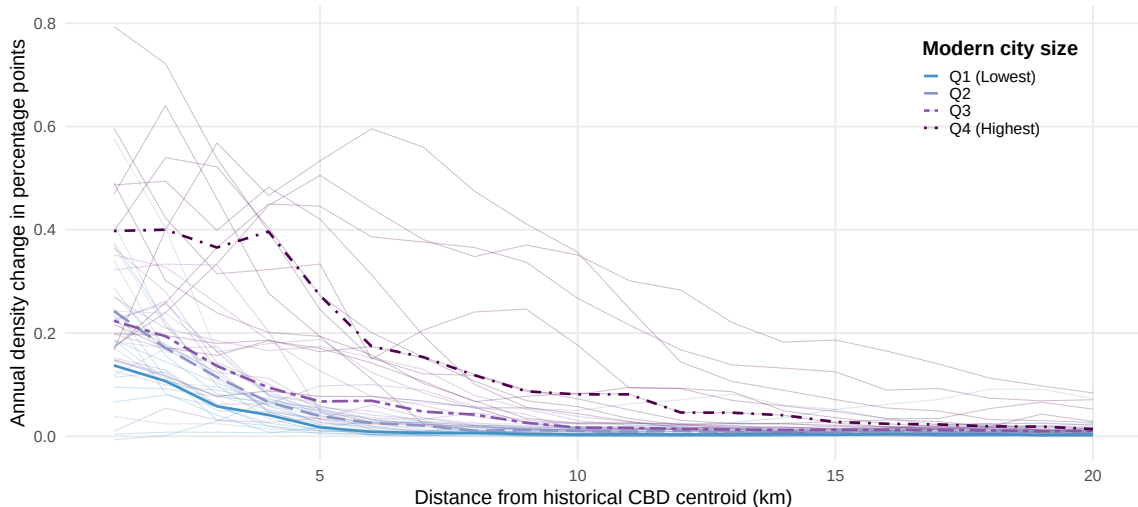
Decomposing Growth



Growth rates



Changes in density by distance to CBD



Conclusion

- Urban growth is a long-run process; data limits constrain our understanding
- The Aerial History Project develops methods for leveraging historical aerial surveys
- This project: 17 countries, 581 cities, 1.1 M images
- Stitched mosaics and predictions will be released publicly
- Potential applications:
 - Research (causal, empirical, descriptive)
 - Urban planning
- Feedback and suggestions welcome!

Thank you!
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