Policy Implications of Different Techniques to Identify Urban Growth Patterns from Satellite Imagery: The Case of Ho Chi Minh City

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PRESENTATION OUTLINE

• **Motivation**: using satellite imagery to measure urban growth, including informal developments

• **Pros**: consistent, low-cost, frequent data of urban growth

• **Cons**: potential error and bias about field conditions, particularly informal construction patterns.

• **Findings**:
  - It is possible to adapt techniques to capture informal construction in HCMC:
  - Compare and contrast 3 different urban expansion studies of HCMC: algorithms are not universal

• **Policy implications**: Need to groundtruth and adapt urban land use change detection to local context
POLICY CONTEXT

Emphasis on INDICATORS to track development

- UN Sustainable Development Goals, SDG 11: “Make cities and human settlements inclusive, safe, resilient and sustainable.”
- Indicator 66: “percentage of urban population living in slums or informal settlements.”

Potential of using satellite imagery to complement administrative data

- *Informal settlements often undercounted* in administrative data (Miller and Small 2003; Barry and Ruther 2005; Carr-Hill 2013)
- *Census data too infrequent* to monitor rapid urban growth (Alkire and Samman 2014)
TECHNOLOGICAL ADVANCES in using satellite imagery for data about urban development

• Sub-meter imagery and increased computing power
• Algorithms combining different analytical approaches (spectral and texture analysis along with different object based approaches) (Graesser et al. 2012; Kit et al. 2012; Taubenbock and Kraff 2014; Vatsavai et al. 2014; Antos, Lall and Lozano-Gracia 2016)
• Tracking growth over time, differentiating land uses and analyzing several cities/countries (Kim et al. 2004; Angel et al. 2005; World Bank 2015; Pesaresi et al. 2013)
CHALLENGES of using satellite imagery for informal urbanization

• “Informality” based on construction quality and urban morphology rather than property titles or access to basic infrastructure:
  - construction materials
  - street alignment
  - density of structure
  - lack of tree coverage

• Informal settlements take different forms across location but also within a same urban area:
  - more or less established
  - central and concentrated vs. peripheral and dispersed
Data and methodology

- Ho Chi Minh City *Spot Image* 10m resolution, 1994 and 2001
- Spectral (thresholding) and Texture (high pass filter) Analysis
  - Texture analysis enables to capture isolated, small informal buildings
  - Field verification
  - Accuracy 94%
- Spatial analysis of location patterns and vulnerability to displacement and disaster.
- Compare findings to two other studies by Angel et al. (2005) using spectral and cluster analysis on 30m imagery and World Bank (2015) using spectral and cluster analysis on 10m imagery
Findings:
Rapid urbanization in Ho Chi Minh City between 1994 and 2001, both formal and informal.
Findings:
Dispersed informal settlements but concentrated in urban periphery, close to roads, and waterways.

Urban Land Use Patterns in HCMC 2001

<table>
<thead>
<tr>
<th>Land Type</th>
<th>% Within Waterways Buffer</th>
<th>% Within Arterial Roads Buffer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Urbanized Land Area</td>
<td>28.1%</td>
<td>49.4%</td>
</tr>
<tr>
<td>Formal</td>
<td>25.7%</td>
<td>52.5%</td>
</tr>
<tr>
<td>Informal</td>
<td>51.7%</td>
<td>29.8%</td>
</tr>
</tbody>
</table>
Findings: Different studies identify the same urban core but differences on the periphery.
Summary of findings

• Satellite imagery enables tracking of urban expansion
• Satellite imagery can detect informal settlements to facilitate inclusive planning
• Groundtruthing and contextualization of algorithms is necessary to decrease error.
Conclusion

• Most algorithms require human supervision and ground checking for calibration and to minimize error (inclusion or omission)
• Inclusive and updated measures of urban expansion important for planning infrastructure and public service delivery as well as for identifying population at risk
• With growth in technological advances, it is time for scholars and industry to discuss tradeoffs in methodology and error reporting standards.
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