Remotely sensed urban tree canopy cover change in Denver, Colorado, 2005–2013

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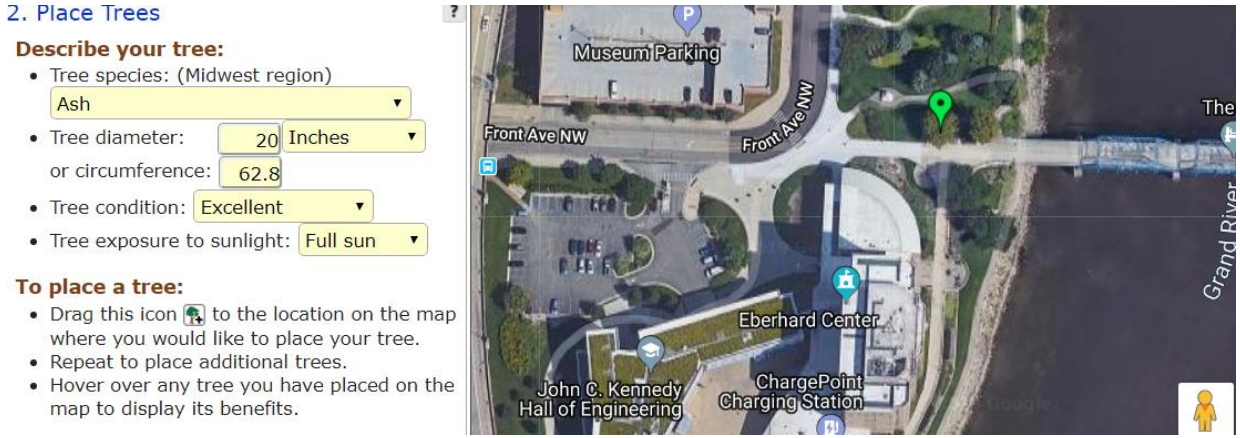
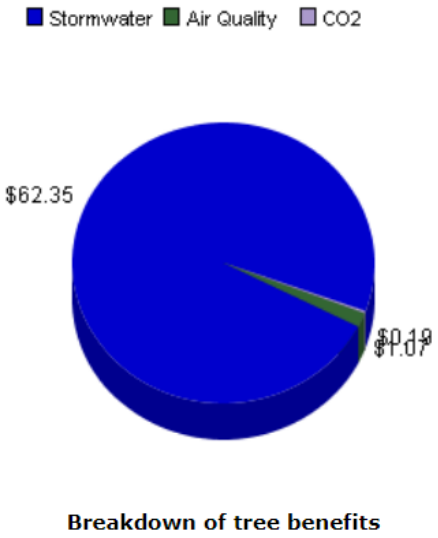
Introduction

- Urban Growth
  - Migration to cities
  - Decrease in urban green space
- Value of green space
  - Pollution removal
  - Prevents erosion
  - Combats urban heat island
  - Provides shade to residents

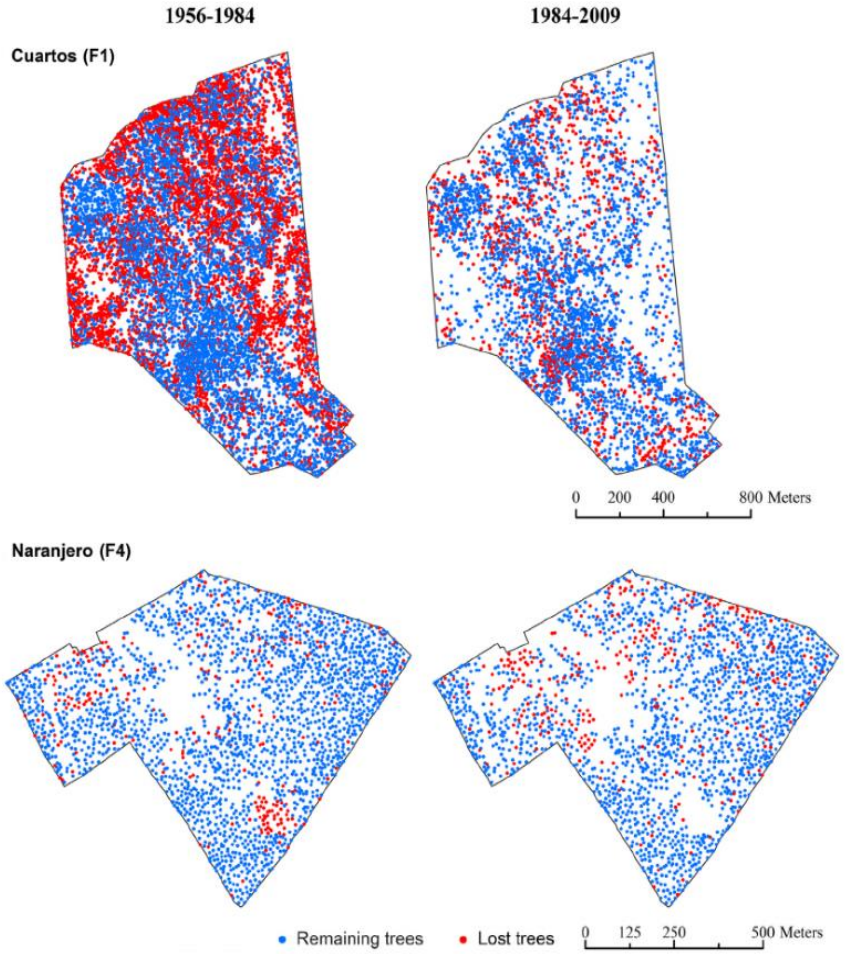




-Sequests 8 pounds of CO2 a year
-Intercepts 2300 gallons of stormwater a year

Introduction

- City/County of Denver Mile High Million (MHM) initiative
  - 1 million trees by 2025
  - Stopped in 2013 due to policy change and imminent emerald ash borer invasion
- Similar studies
  - Oklahoma City
  - Iberian Forest change detection
  - USDA study on MHM



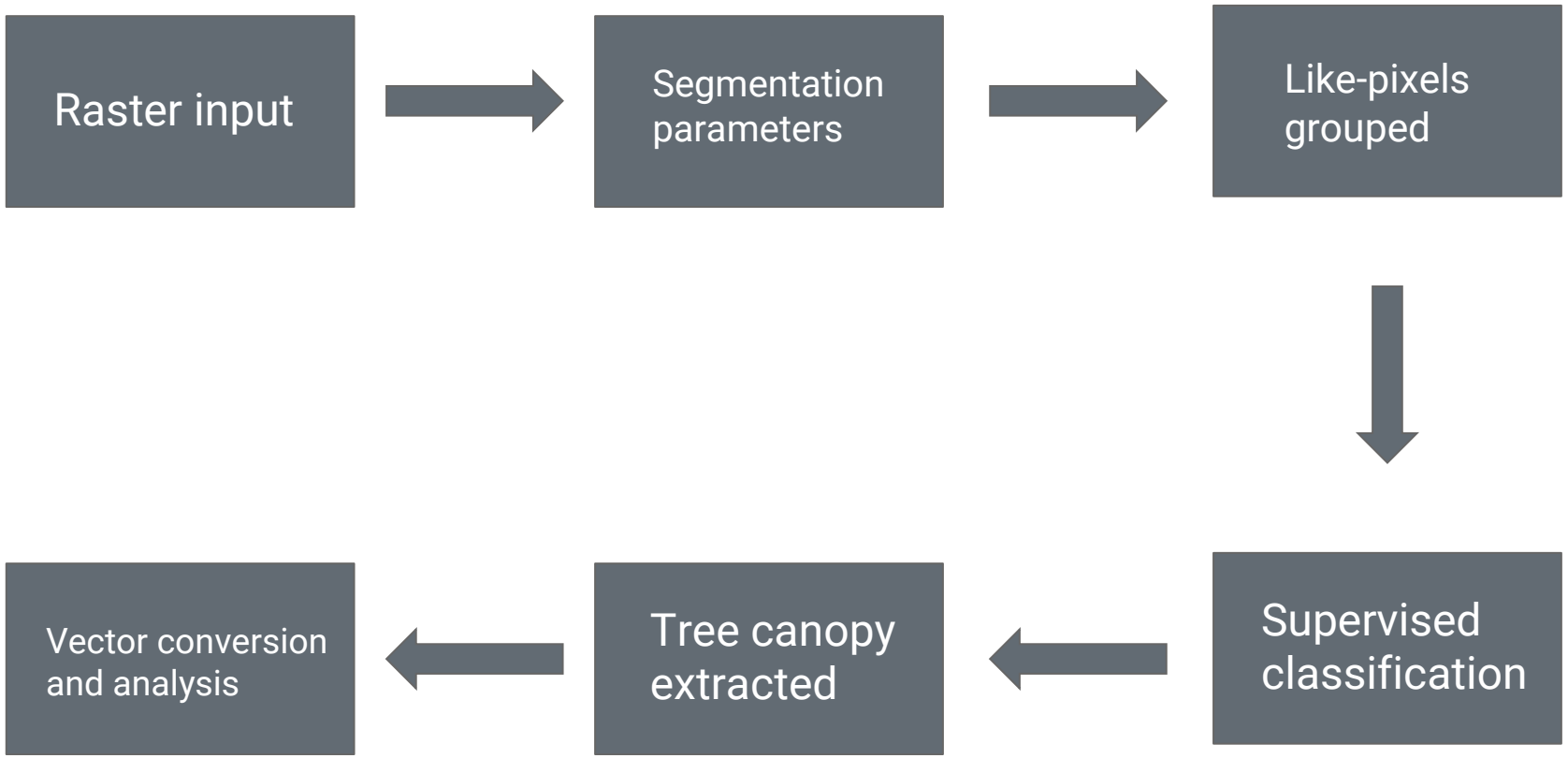
(Sevillano et al., 2017)

Objective

- ***To evaluate tree canopy change specifically in the higher developed areas of Denver, CO, including downtown and surrounding neighborhoods, to see success or failure of the MHM in approximately 25% of the city***

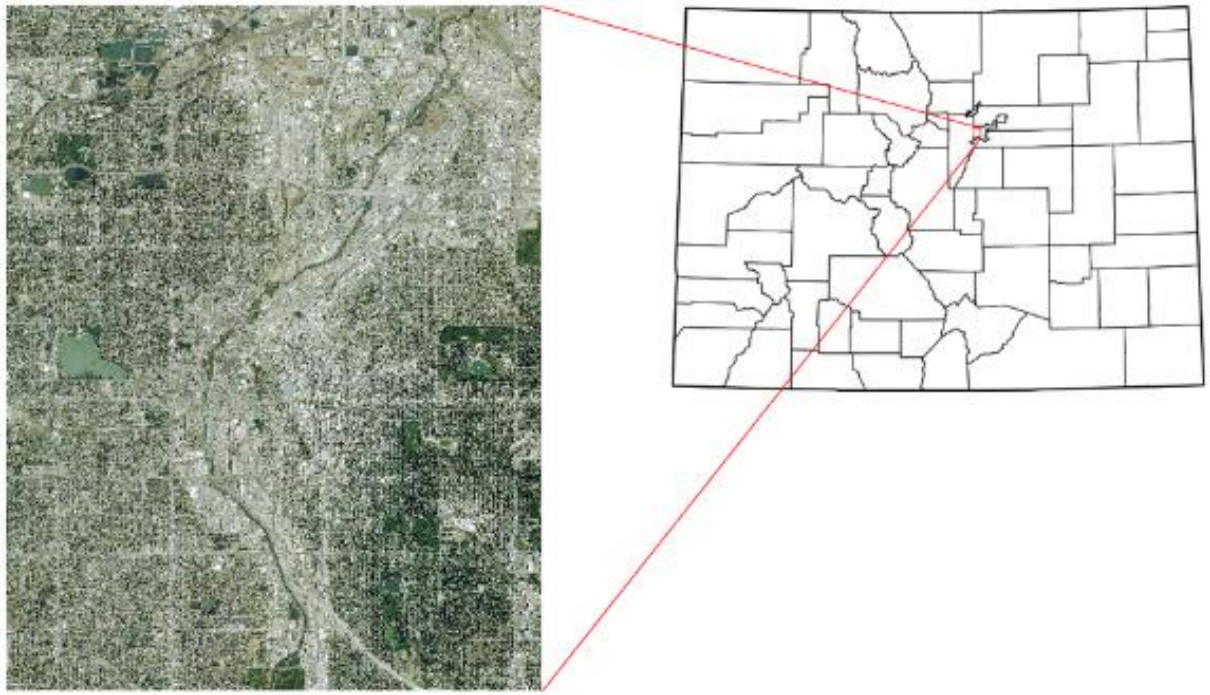
- Localize and expand upon the USDA's comprehensive project

Object-based image analysis (OBIA) using ArcGIS Pro's image classification wizard



Data & Methods

- NAIP Imagery
  - 1x1m spatial resolution
  - RGB + NIR bands
  - New image cycles every 3 years
  - 8-bit radiometric resolution

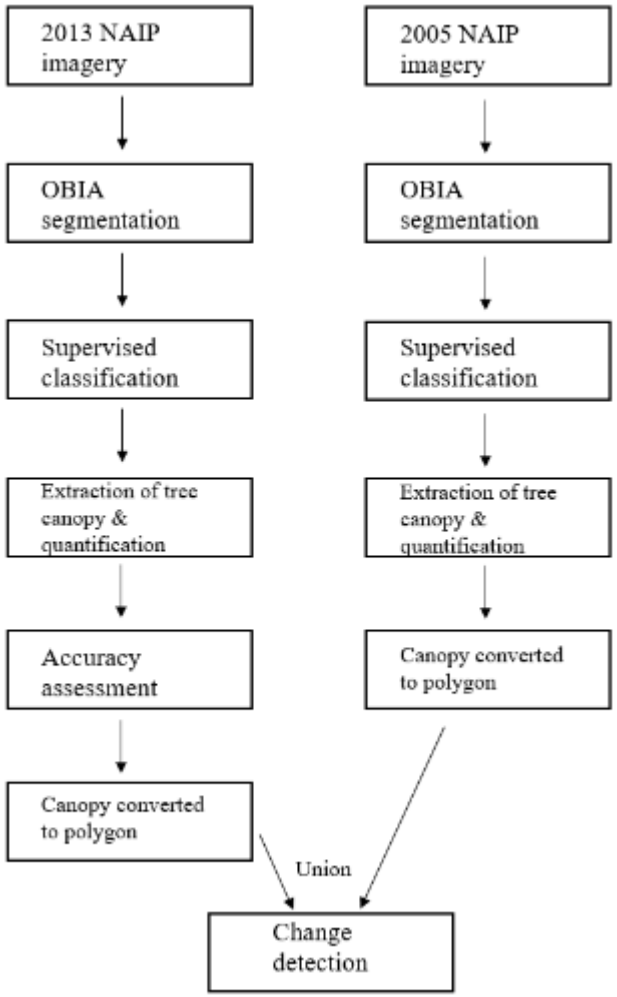


Study area: 163.89km^2

Denver total area: 401km^2

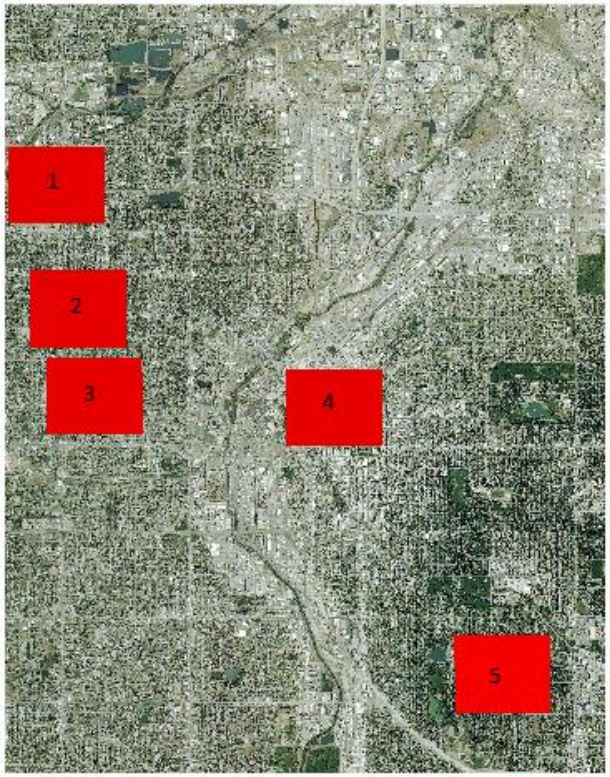
Data & Methods

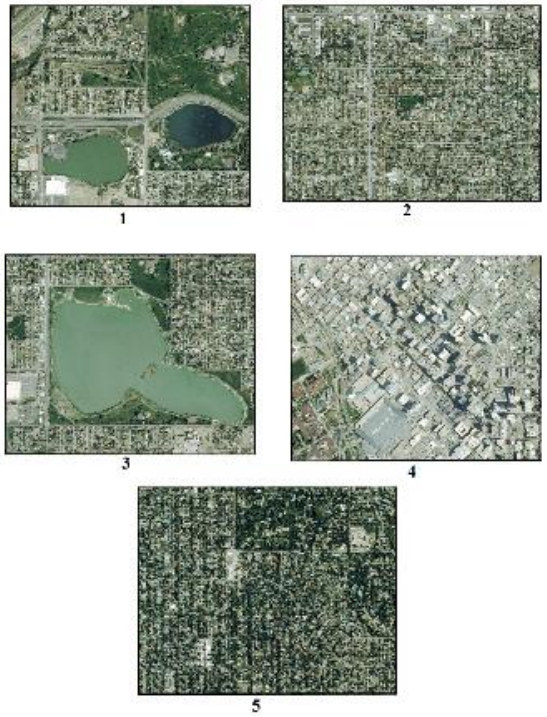
- Methodological workflow
  - Segmentation parameters: 15 spectral/spatial, 10 minimum object size for both datasets
  - Union allows for change detection
- Accuracy assessment
  - 5 sample polygons
  - Average accuracy calculated between all 5
  - Only performed for 2013 due to NAIP uniformity



Data & Methods

- Accuracy assessment polygons
  - Park
  - Residential (2)
  - Natural
  - Urban





Results

Table 1. Total (average) user and producer's accuracy.

Data source	Producer's accuracy	User's accuracy	Total accuracy
2013 dataset	88.88%	86.75%	92.56%

Table 2. Accuracy by land cover type.

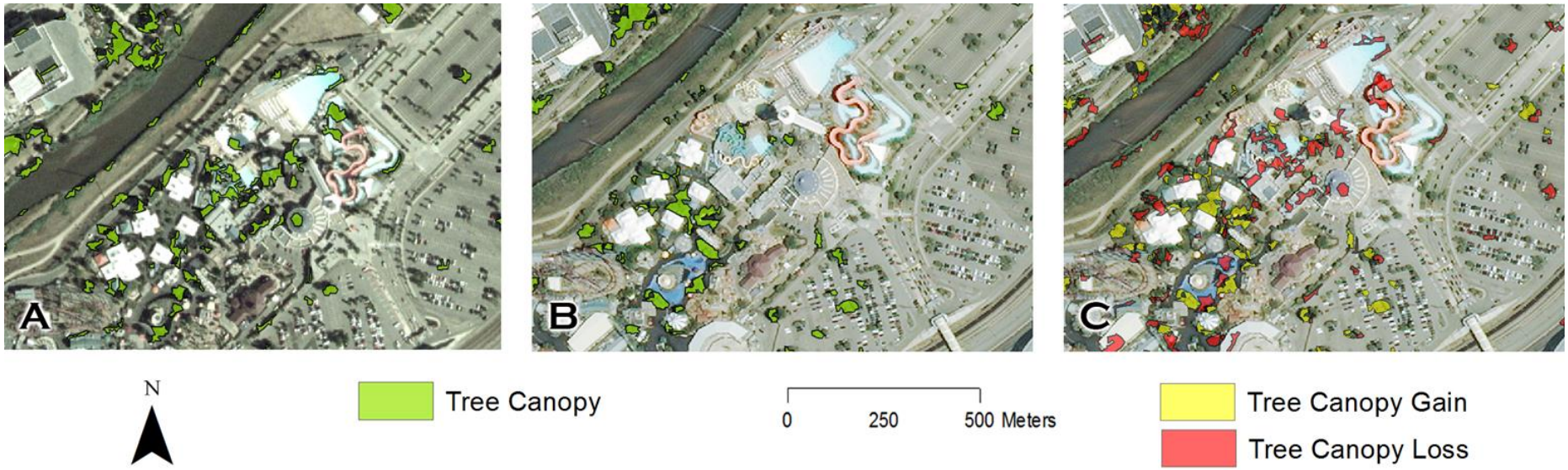
Land type	Producer's accuracy	User's accuracy	Total accuracy
Urban	87.80%	87.80%	93.22%
Residential	87.12%	84.4%	91.94%
2nd residential	90.00%	90.87%	91.67%
Natural	97.27%	88.46%	95.38%
Park (man-made natural)	82.22%	82.22%	90.63%

Results

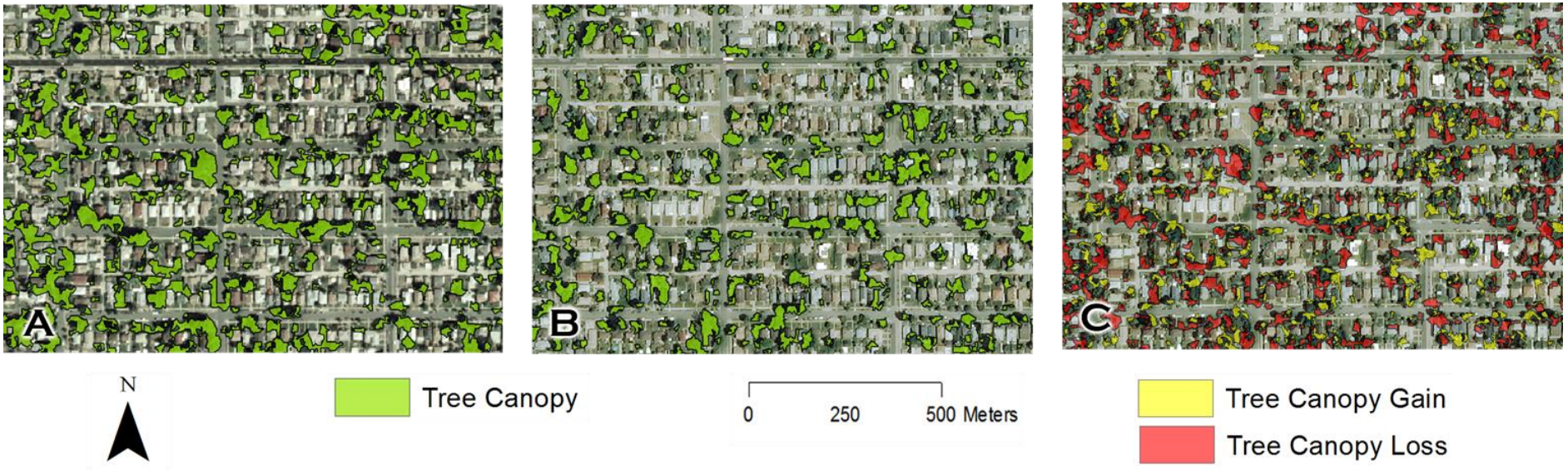
Table 3. Total tree canopy change (2005-2013).

Year	Area (km^2)	Percent (%)
2005	20.09	12.26%
2013	15.95	9.73%
Change	-4.14	-2.53%

Results


A
B
C
N
Tree Canopy
0
250
500 Meters
Tree Canopy Gain
Tree Canopy Loss

Results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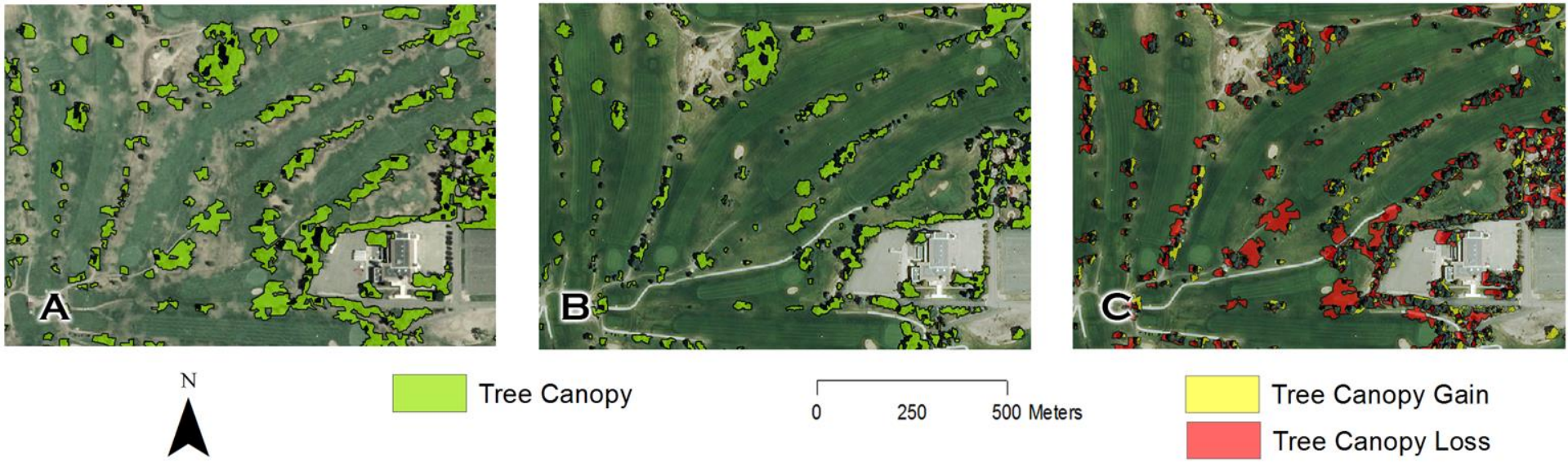
Results


A
B
C
N
Tree Canopy
0
250
500 Meters
Tree Canopy Gain
Tree Canopy Loss

Discussion

- MHM performed poorly in developed areas
  - Proof of regional variability in USDA's study

- Similar studies' accuracy
  - LA million trees feasibility: 88.6%
  - Syracuse, NY tree canopy study: 81.75%

Table 20 Comparison of results from the Denver metro area with other cities. Denver data includes unincorporated areas.

City	Population	Study Area (sq mi)	Tree Cover (%)	Trees	Trees/capita	Tree density (trees/ac)
Metro Denver, CO	2,700,000	721	15.7	10,713,292	4.0	23.2
Los Angeles, CA	3,800,000	471	11.1	6,000,000	1.6	19.9
Sacramento Metro, CA	2,500,000	505	17.0	6,889,000	2.8	21.3
Casper, WY	55,316	21	8.9	123,000	2.2	9.1
Jersey City, NJ	248,000	15	11.5	136,000	0.6	14.4
Chicago, IL	2,700,000	231	17.2	3,585,000	1.3	24.3
Minneapolis, MN	382,000	58	26.4	979,000	2.6	26.2
New York, NY	19,465,000	308	20.9	5,212,000	0.3	26.4
Philadelphia, PA	1,526,000	132	15.7	2,113,000	1.4	25.1

(Mcpherson et al., 2013)

Discussion

- Limitations
  - Shadows classified as tree canopy
  - More shadows in 2005 imagery
  - Required extra training samples
  - Distinguishing spectral response

- Future considerations
  - Continued monitoring of MHM's ash borer maintenance
  - Expansion on other regions not specifically covered in USDA study

Conclusion

- Supervised approach to OBIA
  - High accuracy
  - Efficient analysis
- Adoption of technique
  - Practicality, cost
  - e.g., for city government, non-profit, etc.
  - Tool for future city planning

(GreenPrint Denver, 2013)

Acknowledgments

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Questions?

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