Parcel-based Change Detection Using Multi-temporal LiDAR Data and GIS

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- Introduction
- Study Area and Data
- Methodology
- Results and Discussion
- Conclusions

Introduction

- Why detect urban changes?

- Existing methods for urban change detection

- Research Objectives:
    1. To develop an automated approach to building change detection using multi-temporal LiDAR data;

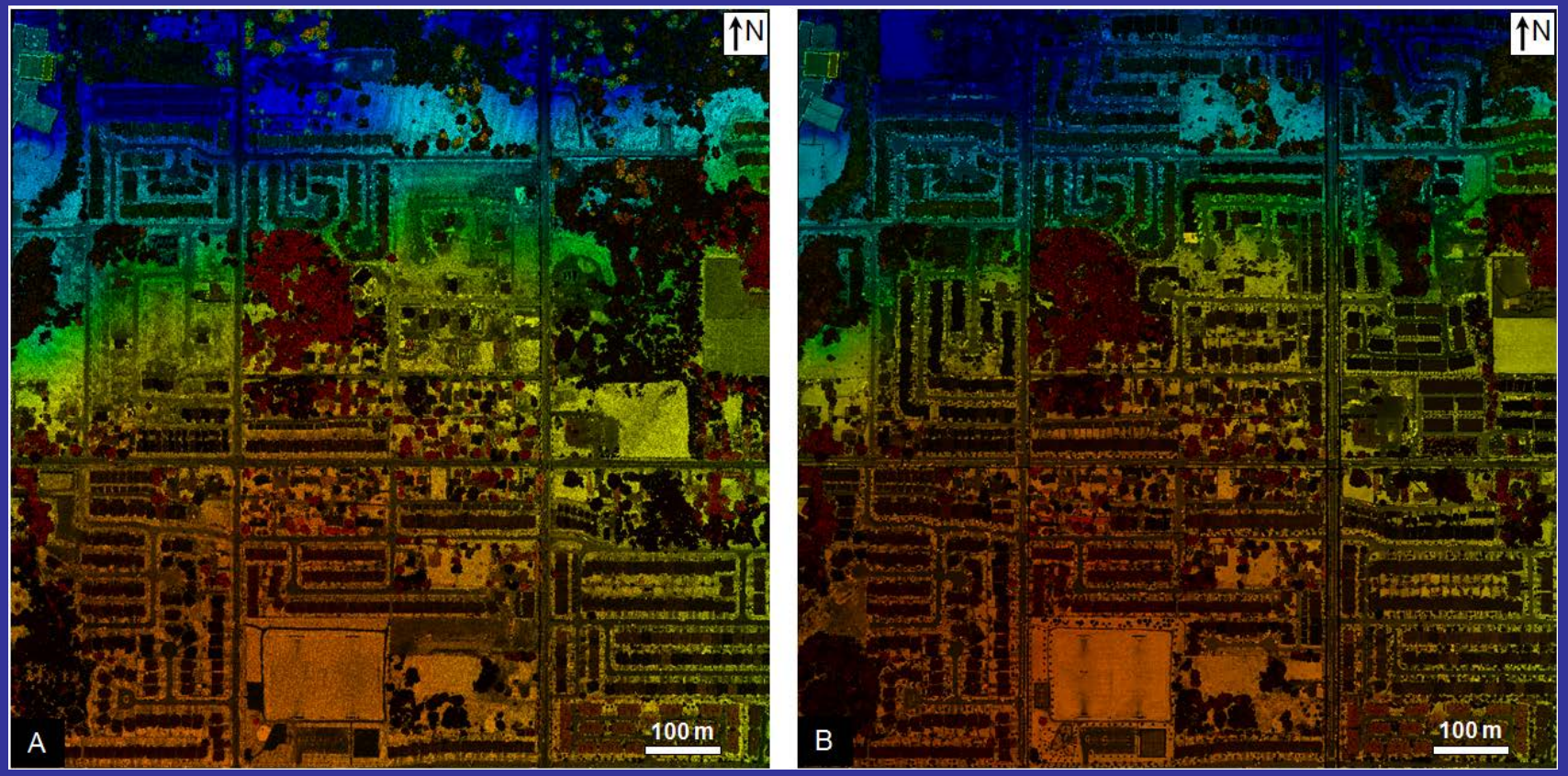
    2. To test an automated procedure for updating parcel attribute data.

Study Area

1 km by 1 km in the City of Surrey, British Columbia, Canada

Data

LiDAR point clouds collected in March 2009 and April 2013.



2009 2013

Data

2009 data:

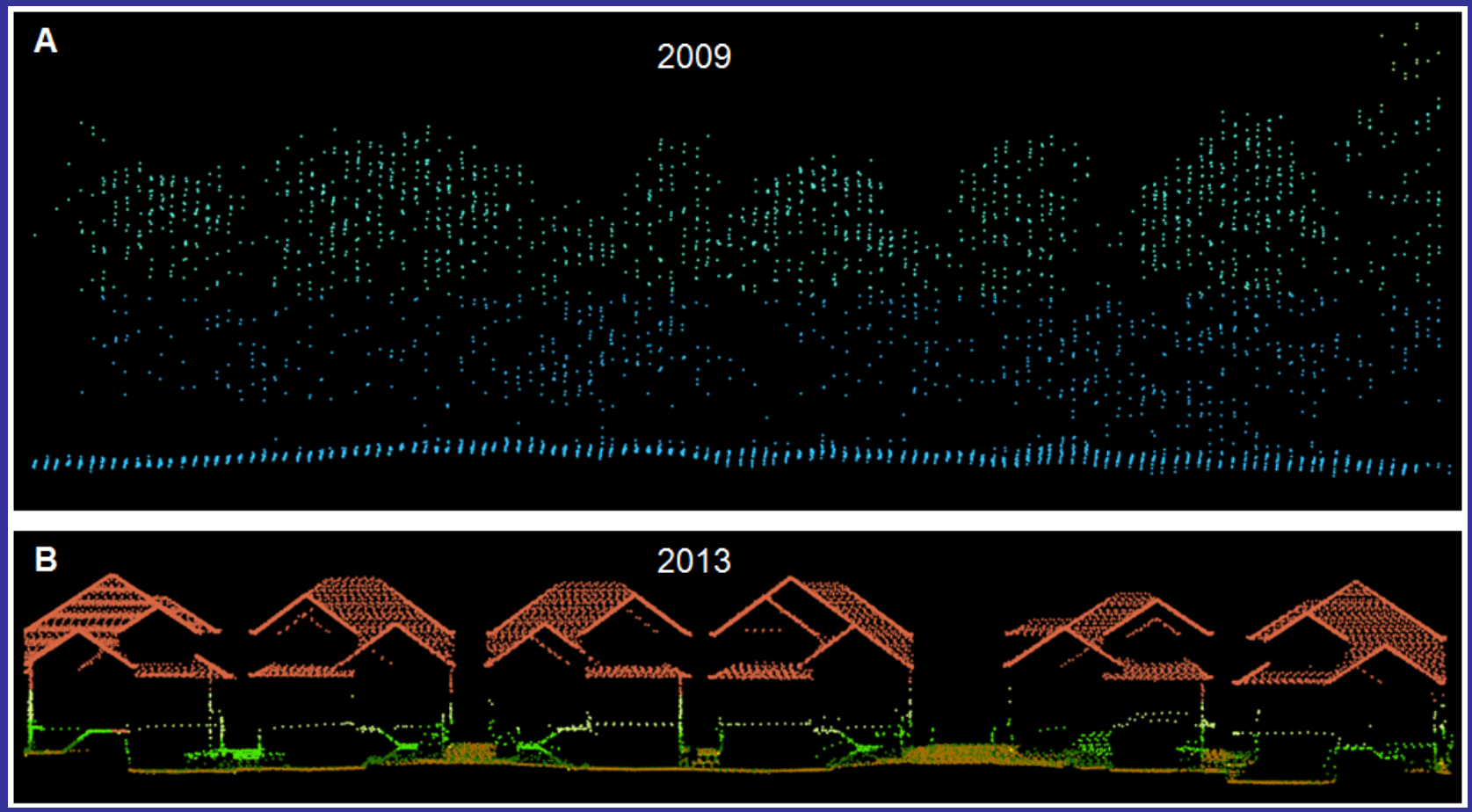
- point density of about 2 points/m^2
- four returns
- five classes: 2 (ground), 7 (noise), 9 (water), 12 (overlap), and 21 (reserved).

2013 data:

- point density of 25-30 points/m^2
- five returns
- eight classes: 2 (ground), 3 (low vegetation, less than 0.7 m), 4 (medium vegetation, 0.7 to 2 m), 5 (high vegetation, above 2 m), 6 (building), 7 (noise), 9 (water), and 11 (reserved).

Data

Sample profiles showing land cover change from 2009 to 2013.



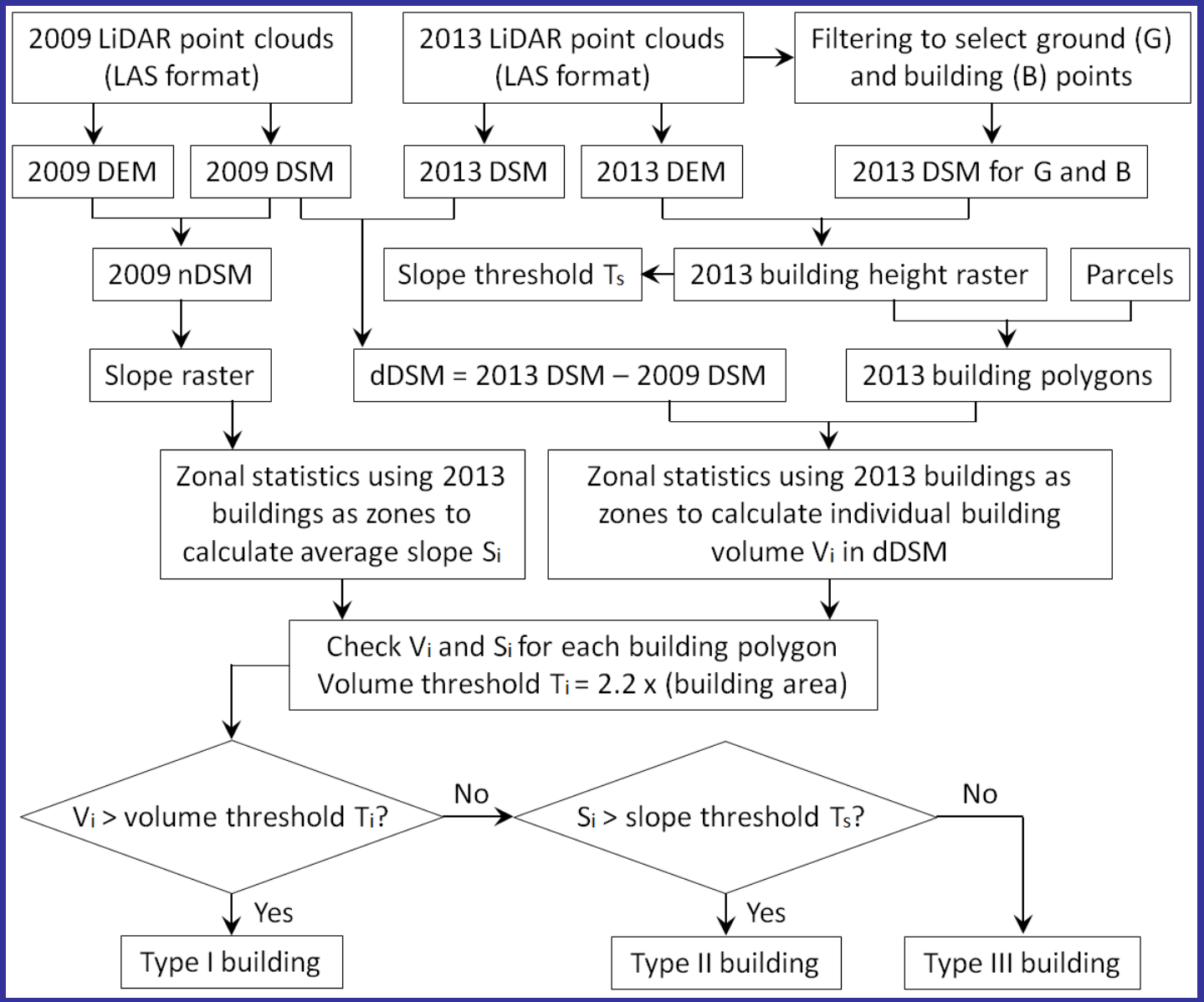
Categories of Building Change:

Type I buildings - new buildings that are mainly built on bare earth or low vegetation.

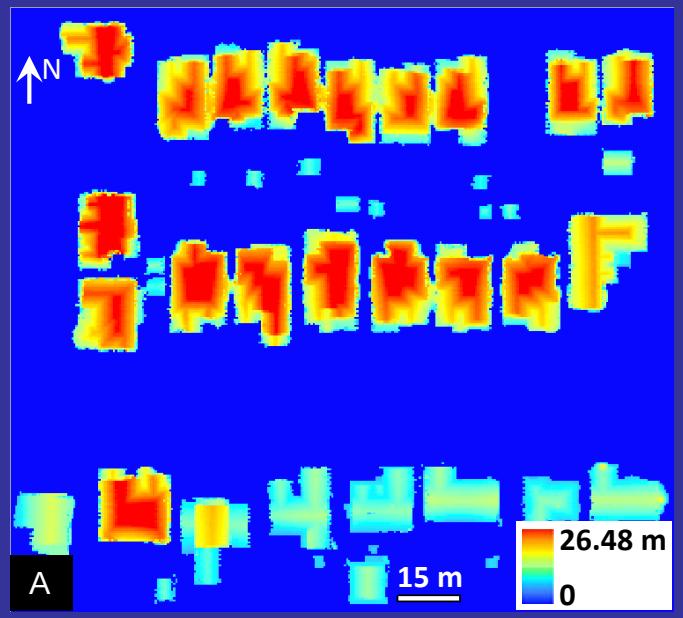
Type II buildings - new buildings that are mainly built after removing medium and high vegetation.

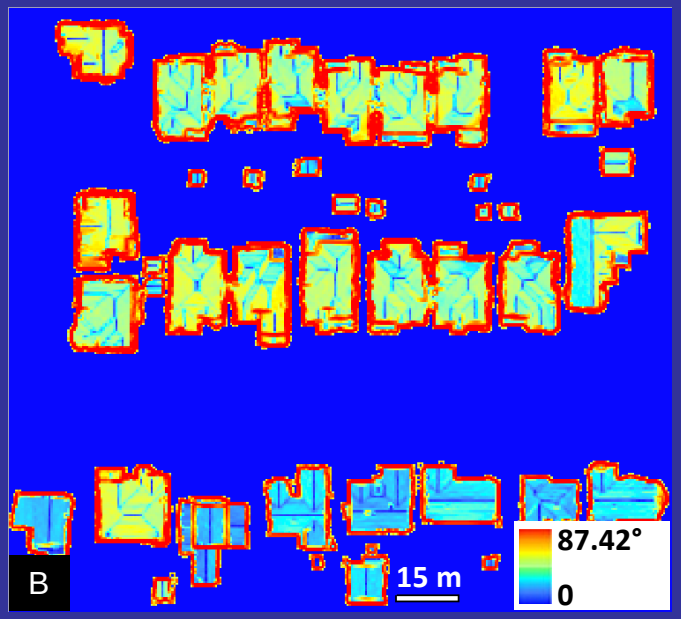
Type III buildings - existing buildings that have no changes or little changes from 2009 to 2013.

Methodology Flowchart



Results

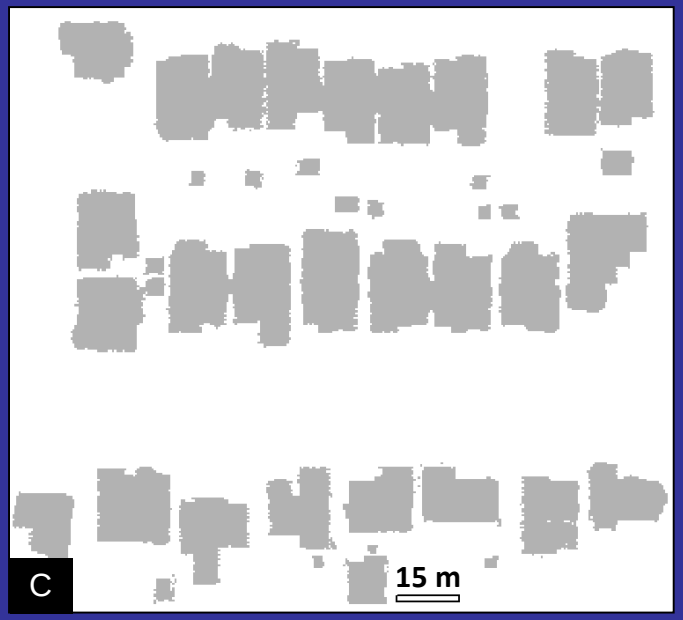


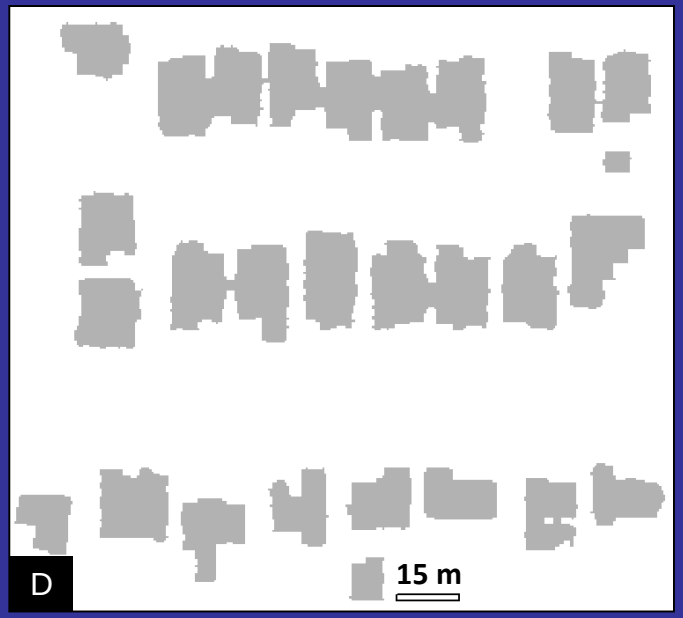


A – Buildings (h >= 2.2 m)

B – Slope of A

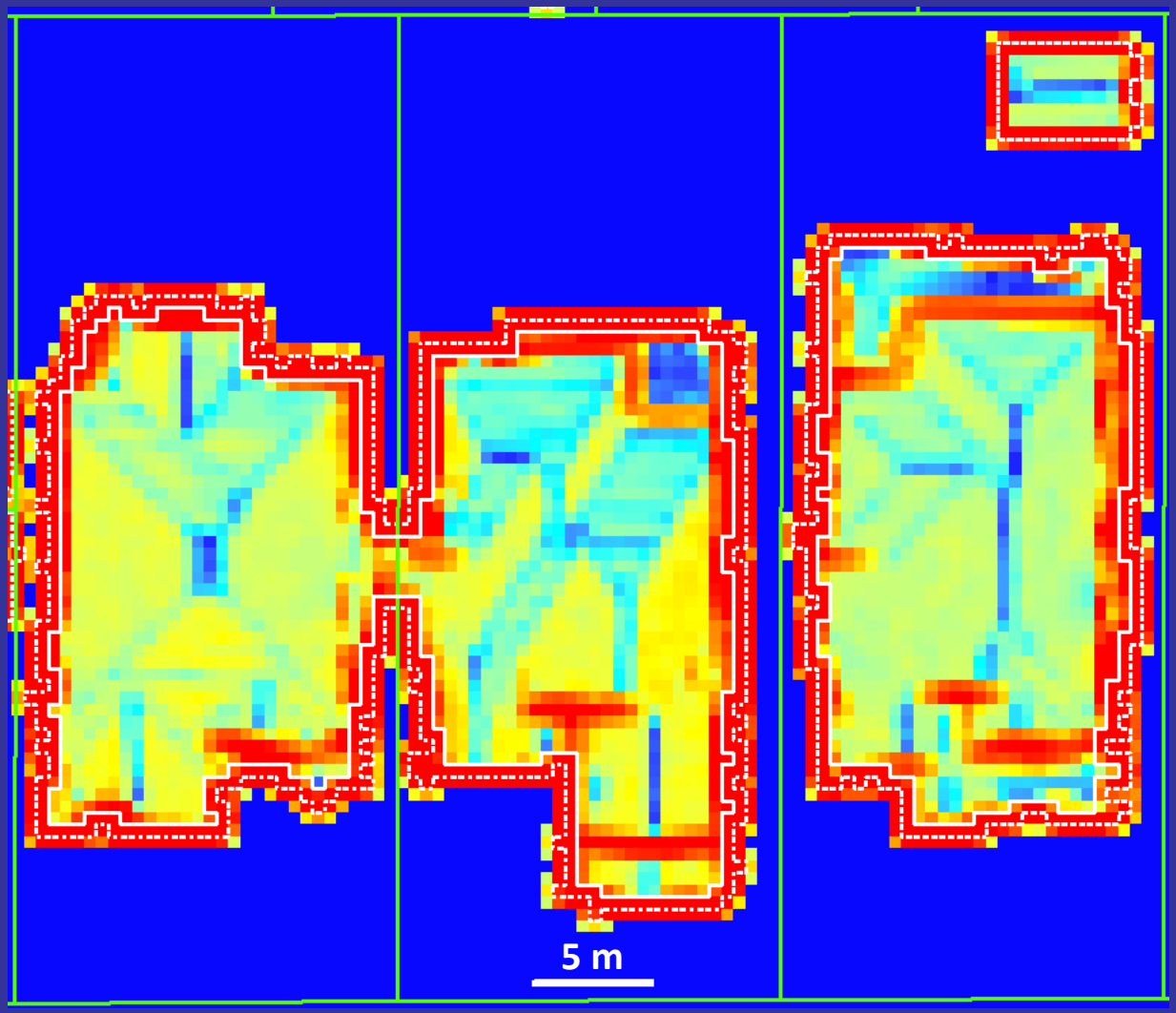
C – Building Footprints



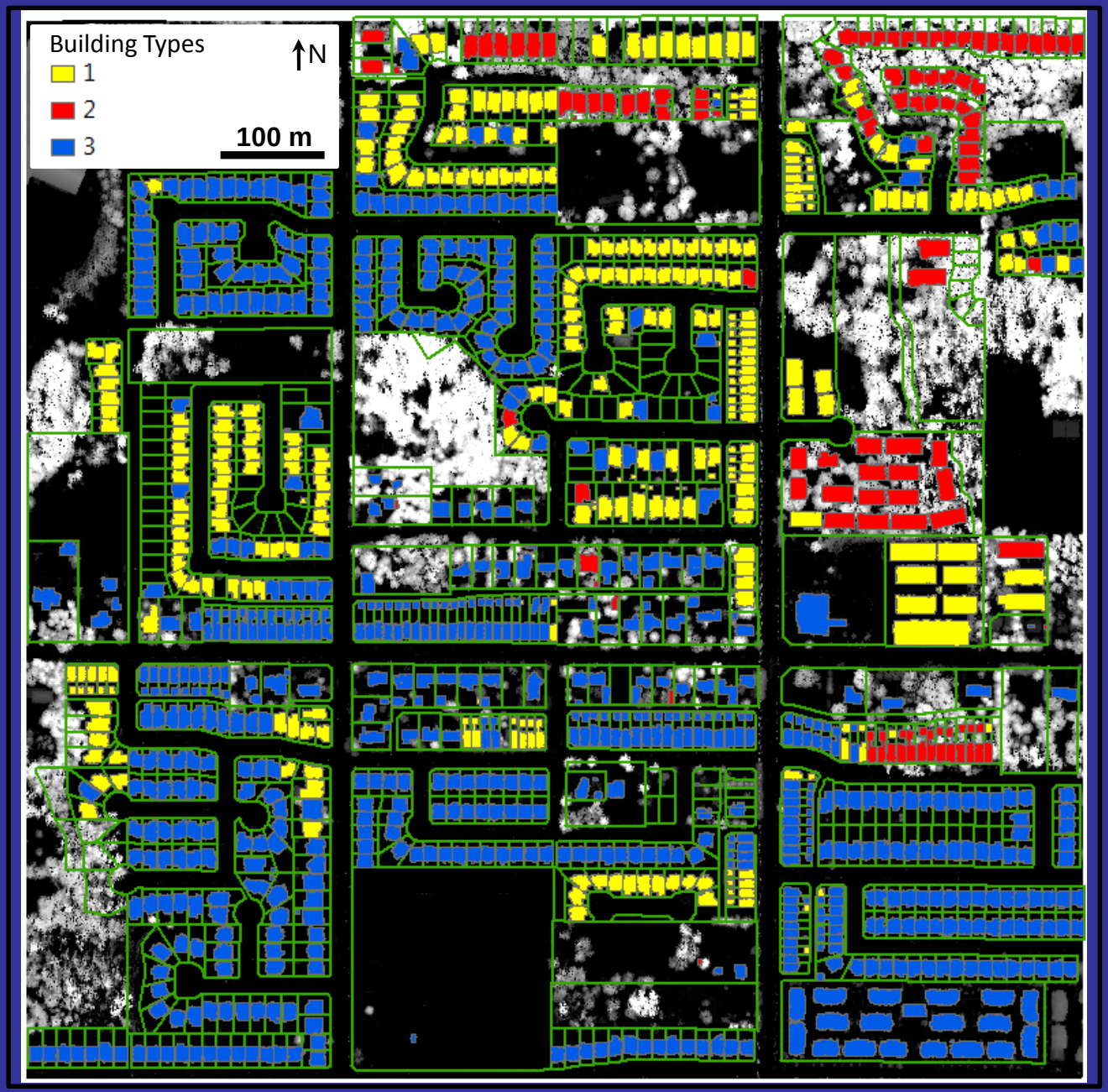


D – Final Buildings (after removing small objects and mathematical morphological operations)

Mathematical morphological operations to remove edge effects from the slope raster.



Results and Discussion



Accuracy Assessment

Quantitative measures:

- Completeness
- Correctness
- Quality

$$\text{Completeness} = \frac{TP}{TP + FN}.$$

$$\text{Correctness} = \frac{TP}{TP + FP}.$$

$$\text{Quality} = \frac{TP}{TP + FP + FN}.$$

TP – true positive

FN – false negative

FP – false positive

	Completeness	Correctness	Quality
Type I Building	0.97	0.91	0.89
Type II Building	0.96	0.93	0.90
Type III Building	0.97	0.98	0.95

Conclusions

- Detection of building changes can be automatically implemented using parcel-based zonal statistics of building heights and roof slopes, combined with mathematical morphological operations and analysis of volumetric changes.

- The method provides an efficient way for updating parcel attributes in GIS.

- The automated approach to building change detection using multi-temporal LiDAR data can also be applied to disaster damage assessment.

Acknowledgment

Thanks to the City of Surrey, British Columbia for providing the LiDAR data.

Thank You!