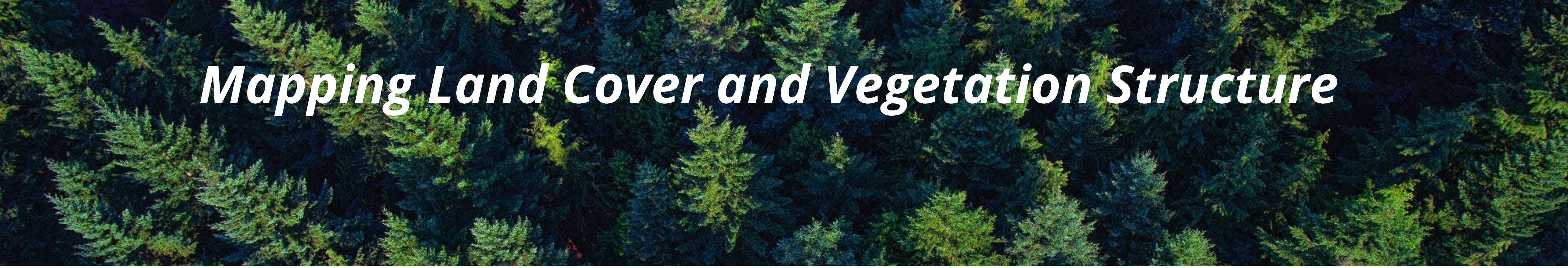

# *Mapping Land Cover and Vegetation Structure*


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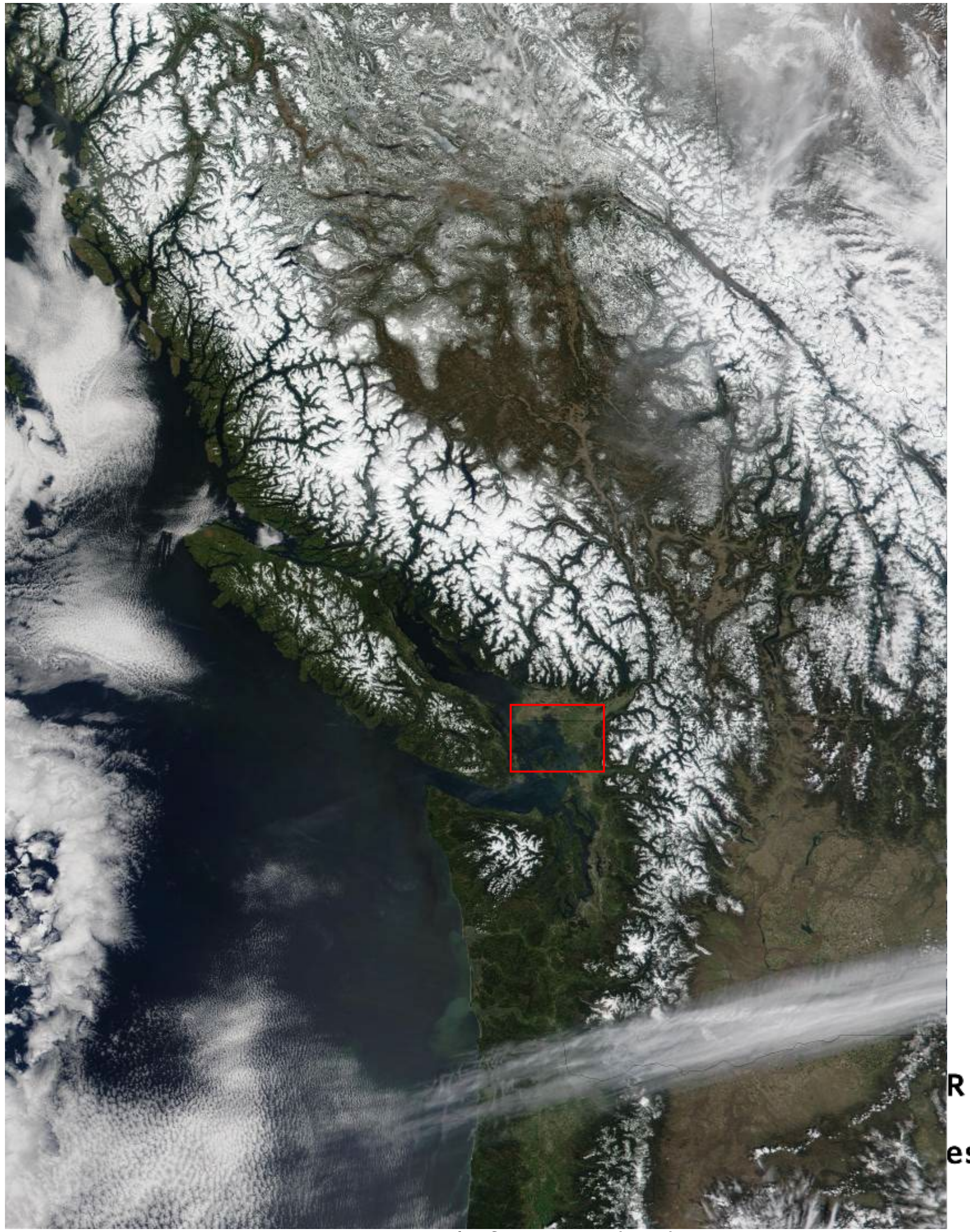
# We need detailed information of land cover / Vegetation structure for a wide variety of applications

- There is no global or Canadian standard classification system with agreed classes and definitions
- Many municipalities develop their own classification system based on:
  - Need – How will it be used
  - Cost – How much money do they have
  - Update – Is it a one off or does it need regular updating ?

- Conventionally municipalities flew aerial imagery and manually delineated land cover types using local knowledge
  - Expensive
  - Required trained staff
  - Range of applications of the data often exceeded the data quality or design
  - Not amendable to digital analysis in GIS

- Move towards satellite data for urban and regional land cover assessment
- More recently LIDAR data provides additional information on vegetation height and complexity
- Still some classes that are not possible to map

# Low spatial resolution (>100 m):


MODIS Image. NASA Platform. Used with permission

**Platform**: MODIS

**Sensor**: Terra; Aqua

**Spatial resolution**:
250 m – 1 km

**Applications**:
-Broad global land-cover types
-snow cover
-canopy cover
-sea surface temp
-vegetation phenology

**Acquisition cost**: free

# Medium spatial resolution (<100m):


Vancouver, Landsat

**Platform**: Landsat / Sentinel 2

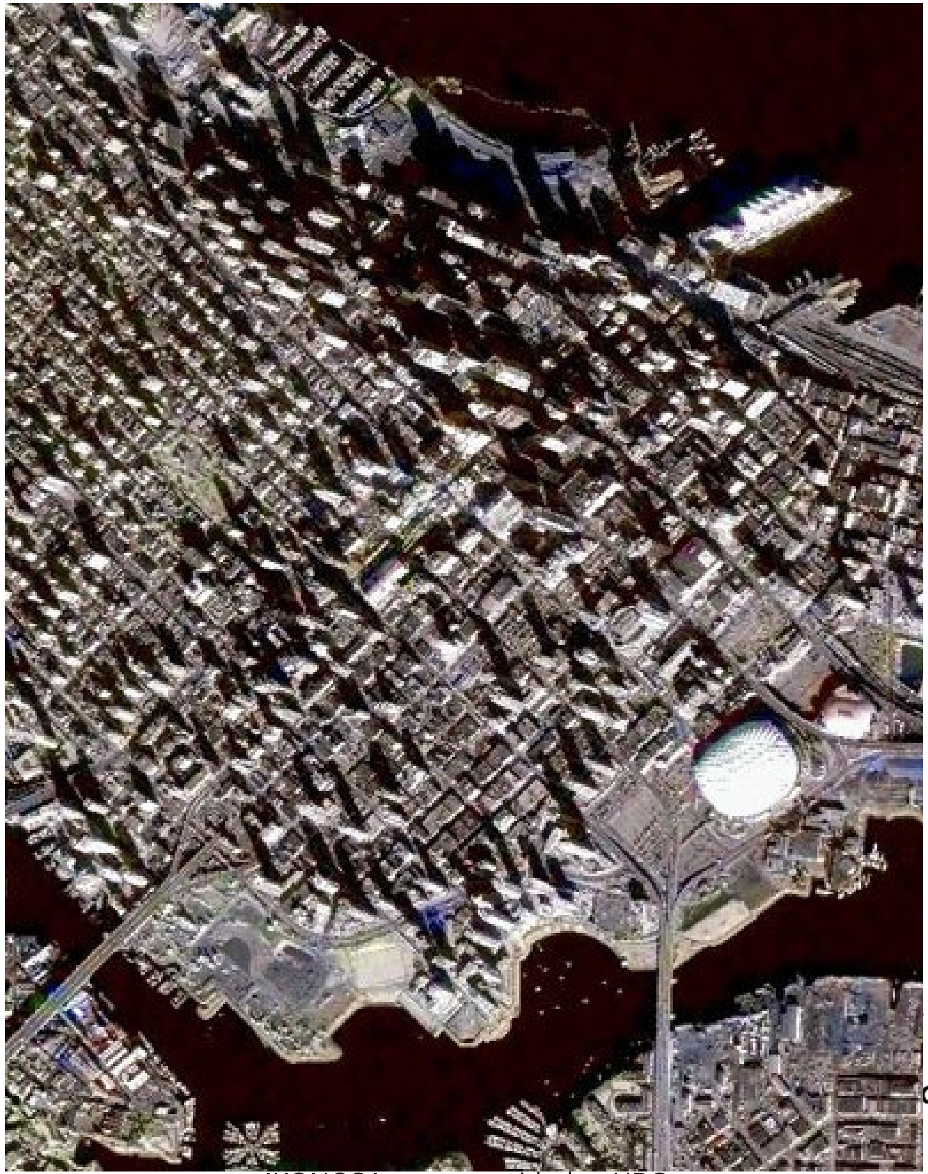
**Spatial resolution**: 10 - 30 m

**Applications**:
-forest cover
-insect infestation
-crop forecasting
-coastal wetland erosion

**Acquisition cost**: free
-typically government

Vancouver, Sentinel -2

# High spatial resolution (<5m):



IKONOS Image: provided to UBC

**Platform**:

Rapideye (no longer operations)

PLANET,

Spot 6

**Spatial resolution**: < 5m

**Applications**:

-urban mapping

-road mapping

**Acquisition cost**: $

-typically private

# SPOT 6


Location : Vancouver, Canada
Sensor : SPOT-6
Resolution (GSD) :
SPOT 6 Satellite Image - Vancouver, British Columbia, Canada © 2012 Astrium Services

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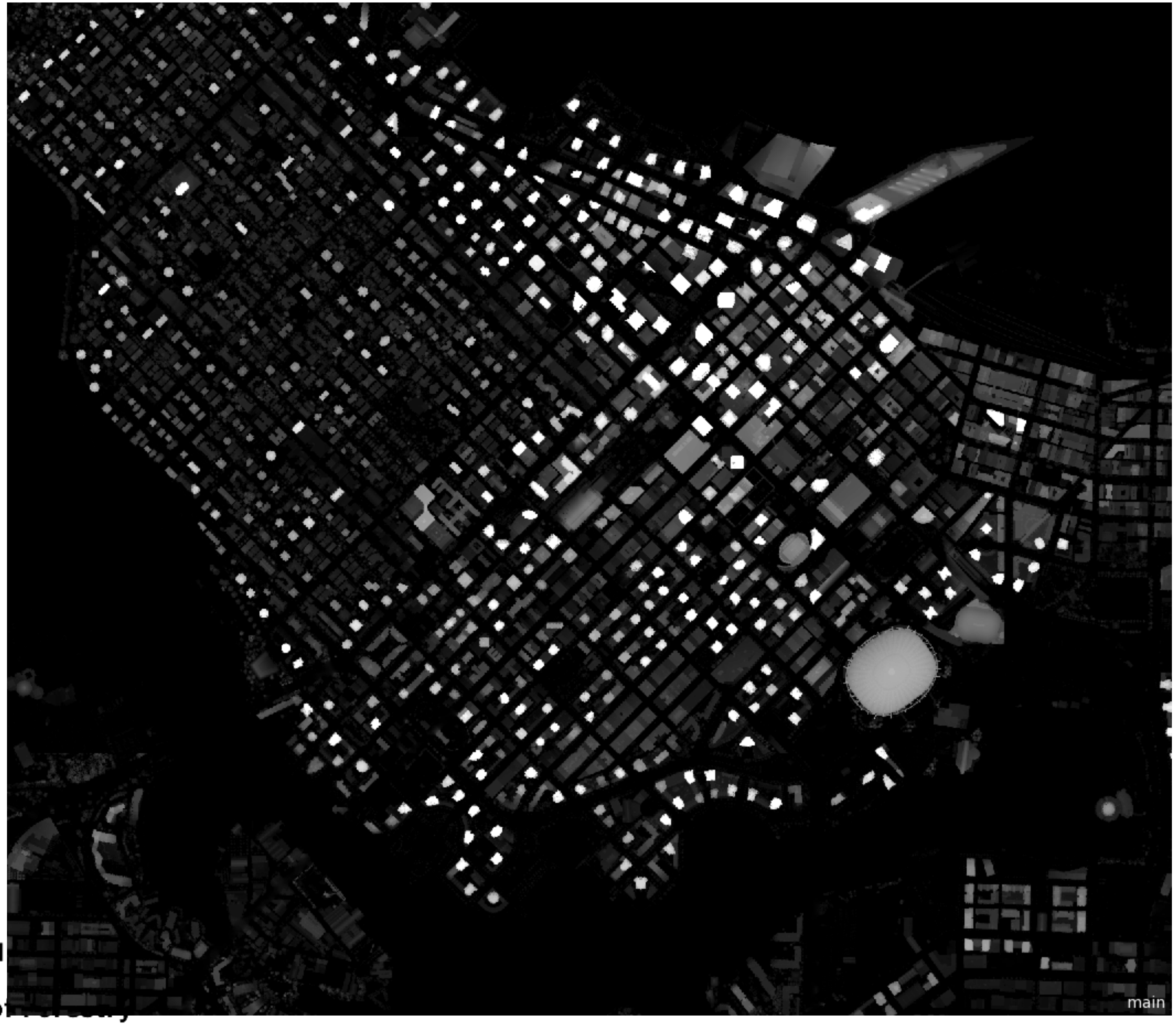
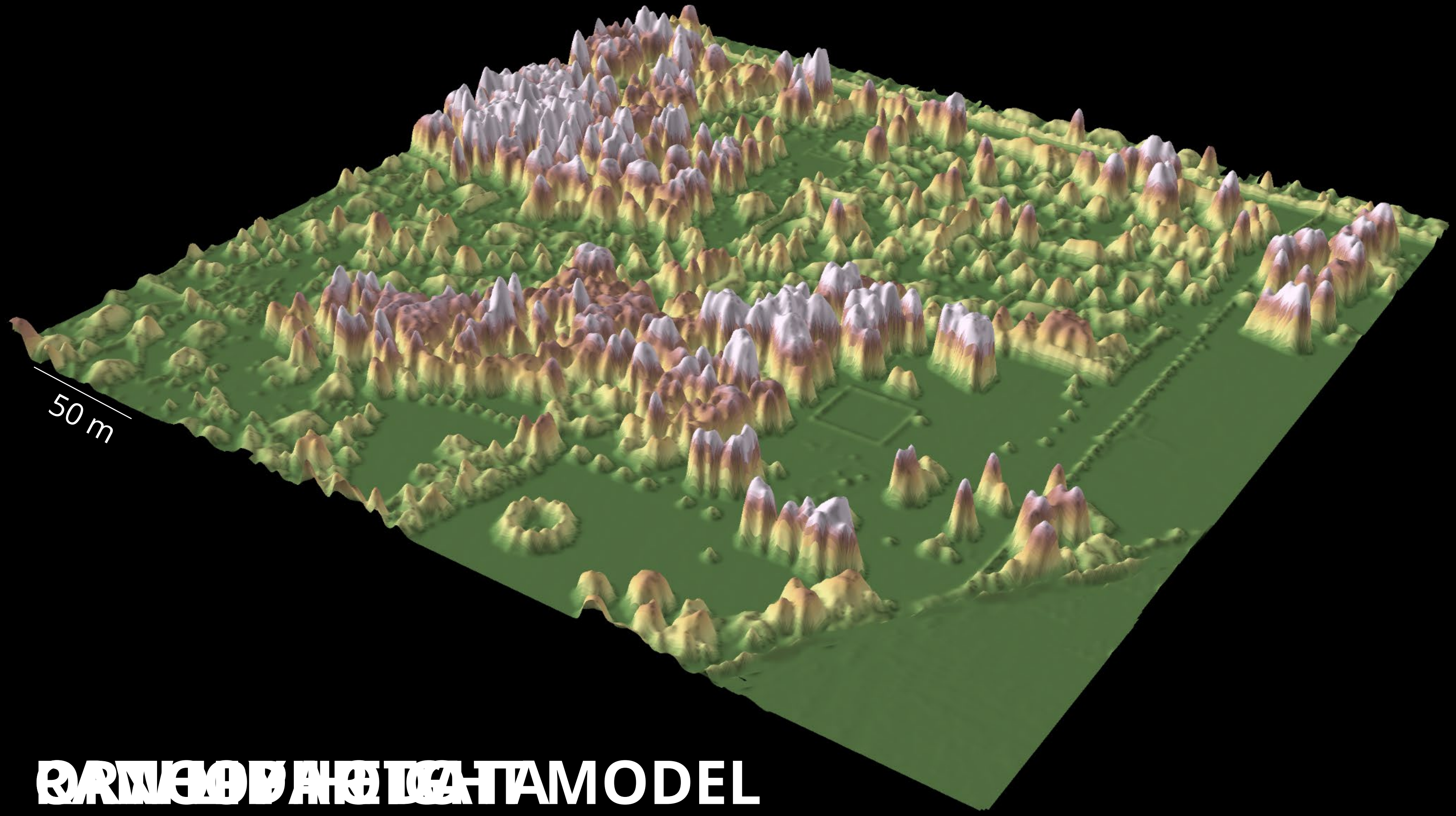
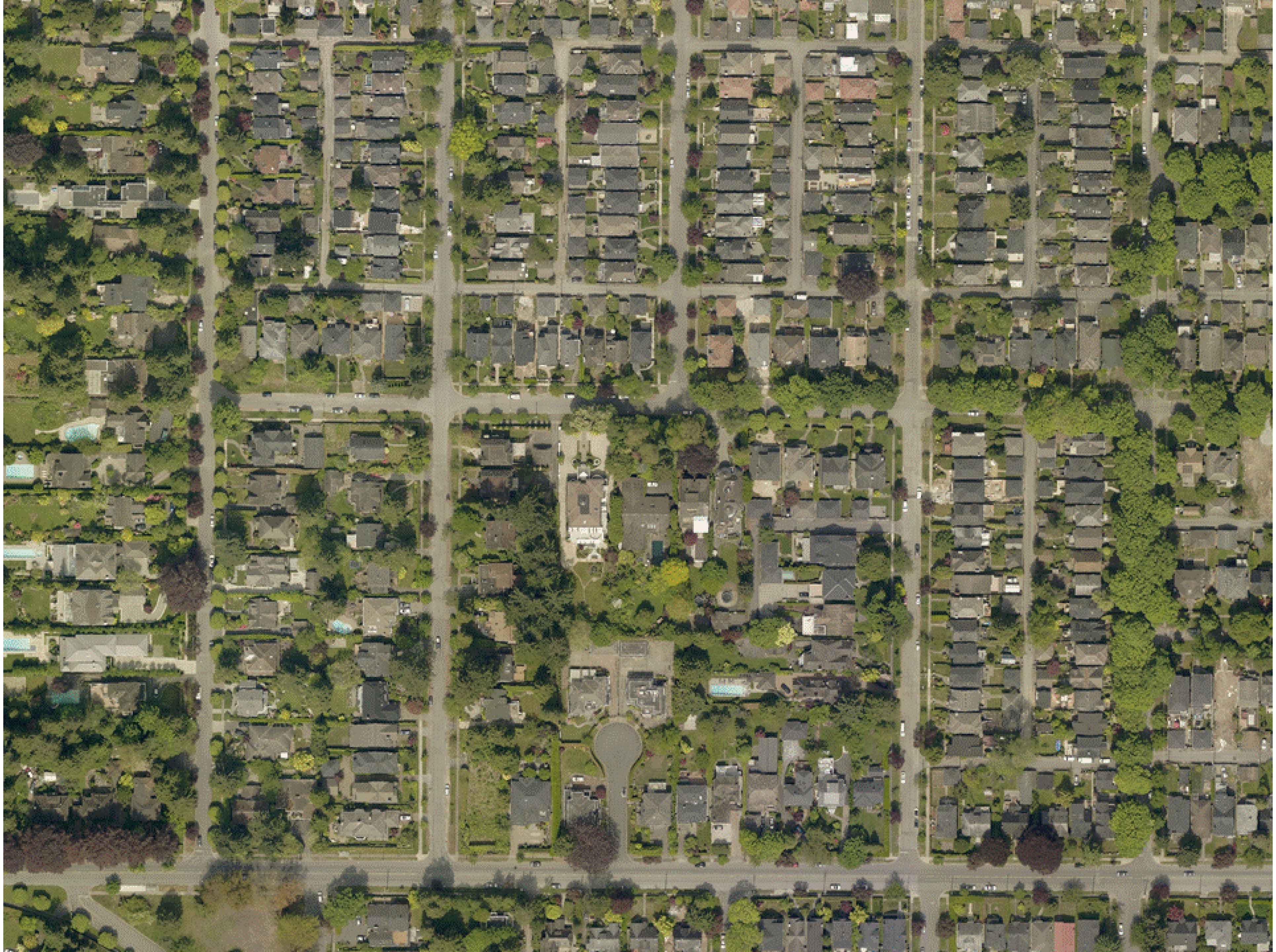
LiDAR provides 3D structure data at high resolutions (<1m)

- **n**ormalized **D**igital **S**urface **M**odel (nDSM)
- Digital Elevation Model (DEM)
- Point Cloud Metrics






# CANOPY HEIGHT MODEL

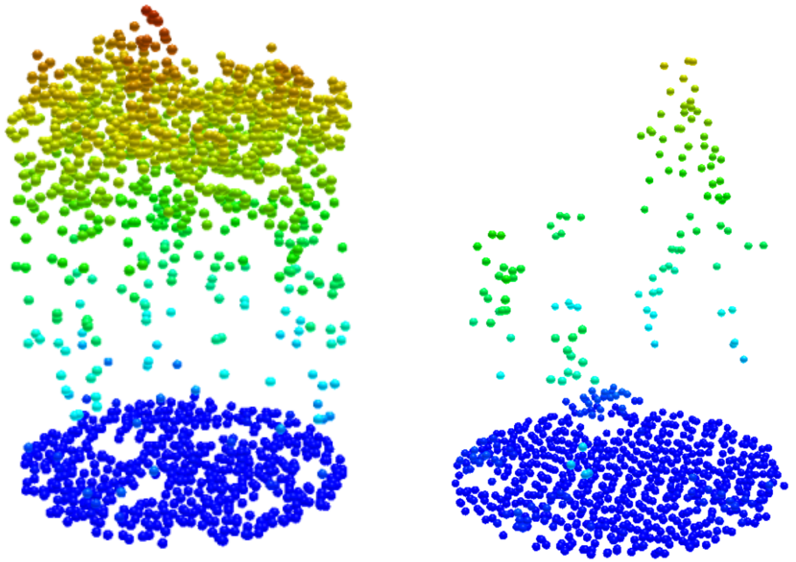


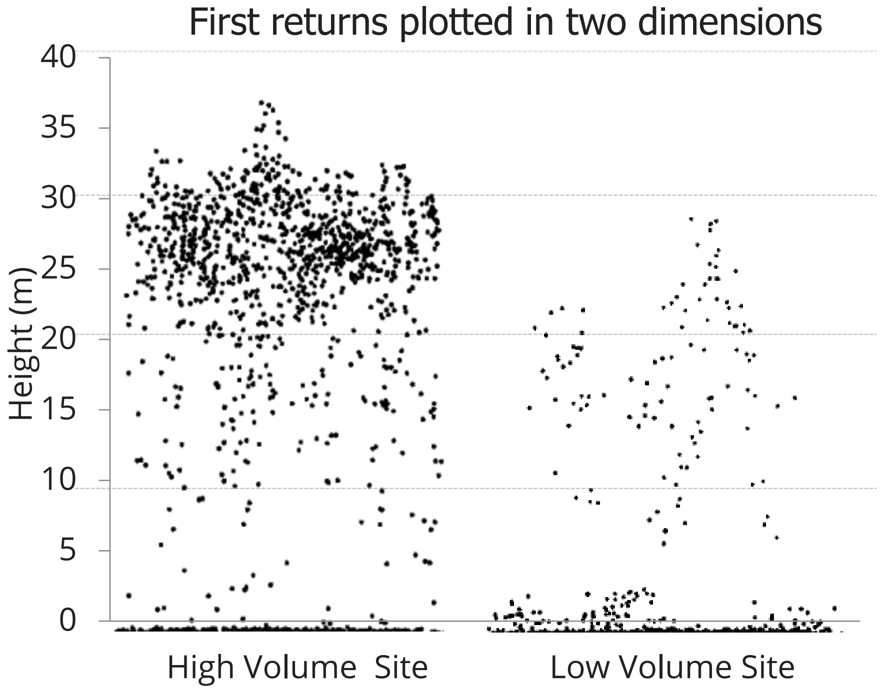
- Accurate for tall trees; misses many lower trees
- Difficult to predict species

- In realty we map clumps of trees in urban areas;
- And then in forested areas we do an Area Based Approach, typical to what we do in forestry

# Plot Level Analysis

- Derive LIDAR metrics in a given grid size (say 10 x 10m)

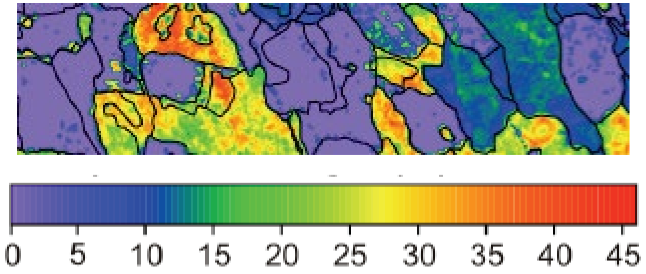




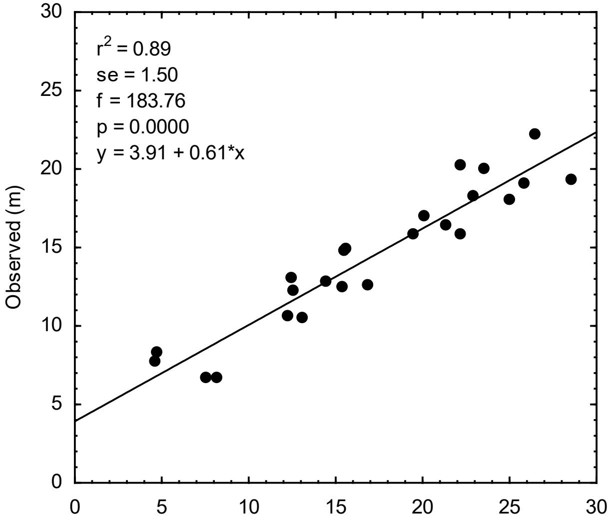

LiDAR visualizations produced with FUSION/LDA software – USDA Forest Service

# How do we relate LIDAR to ground data?

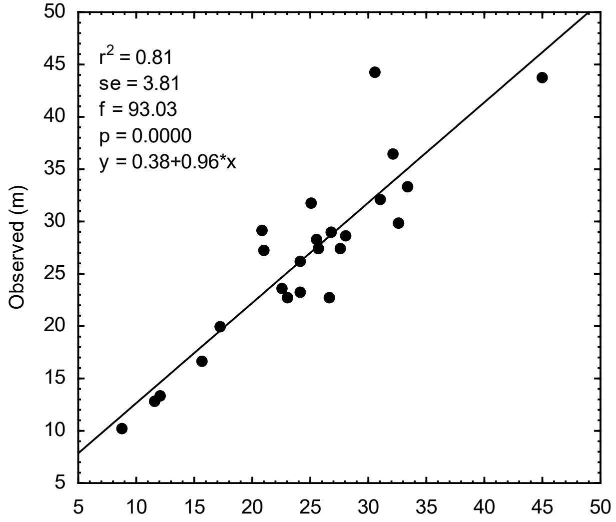
- GPS ground plot location
- Make ground measures
- Statistically relate ground measures to lidar metrics
- Can apply these relationships across all lidar grid cells (10 x 10m)
- Models can be of height, volume, biomass etc.



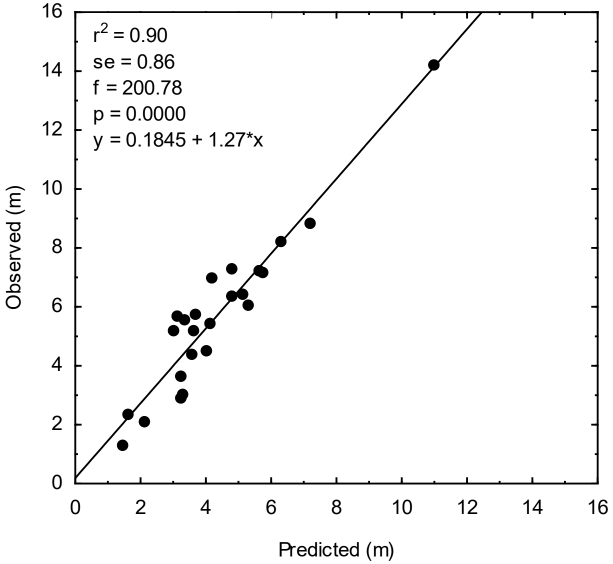

Mean tree height



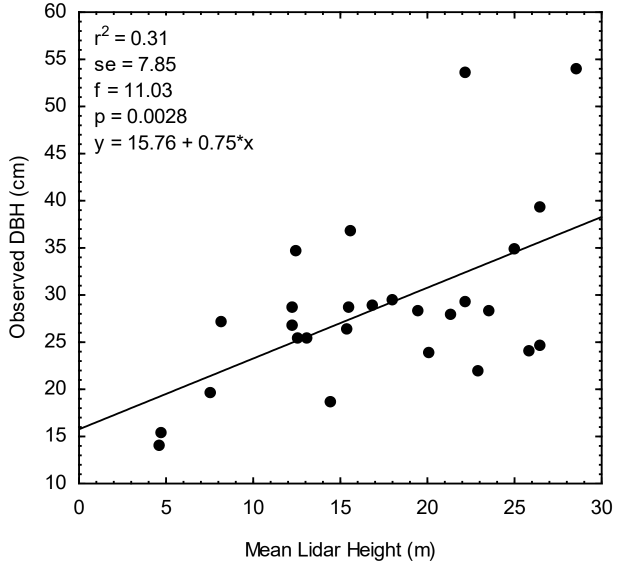

Maximum tree height



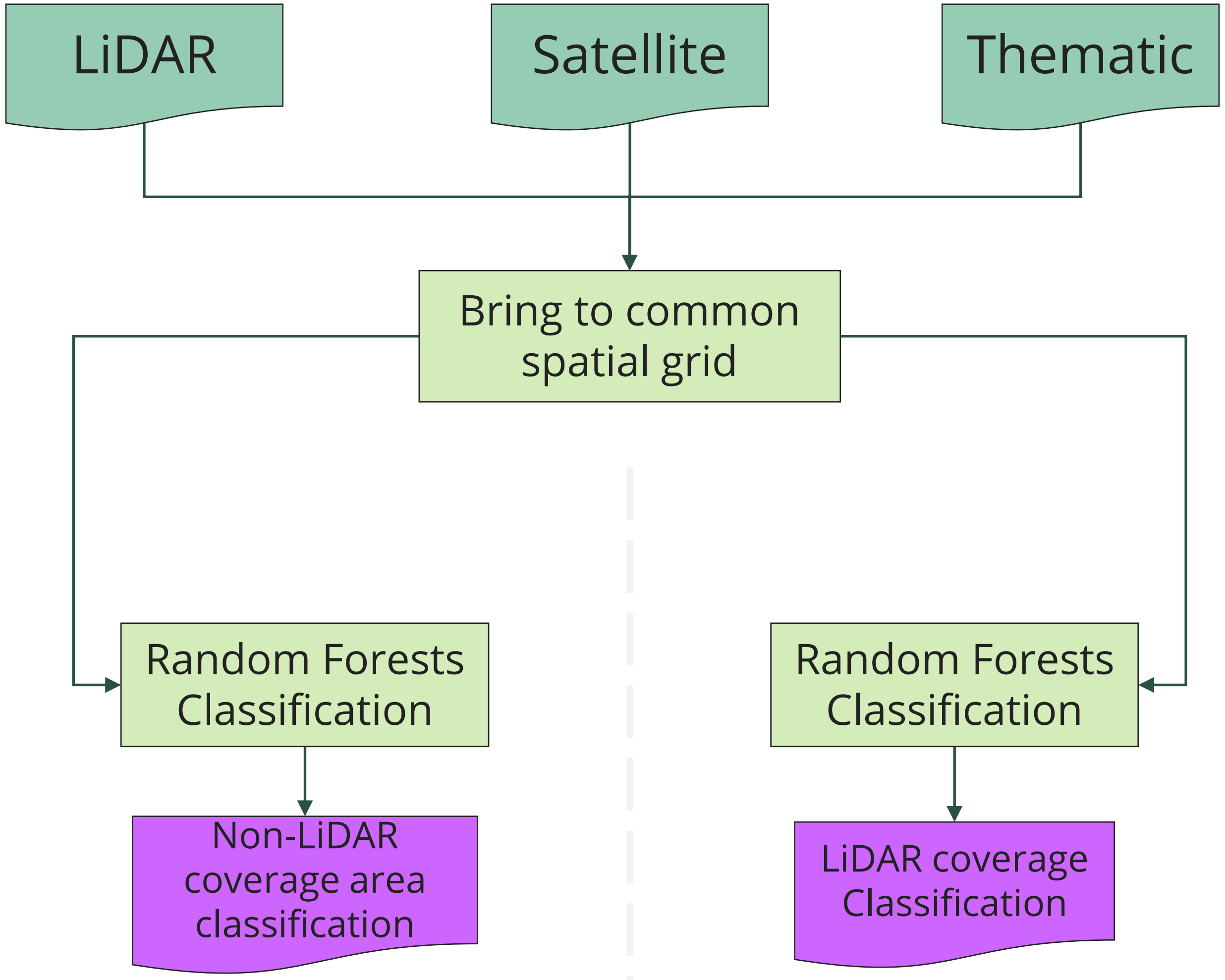

Variation of tree height




Mean diameter (dbh)



But we don't have LIDAR everywhere, it is of different dates, densities and flown by different providers




Classification for areas without LiDAR coverage

Classification for areas with LiDAR coverage

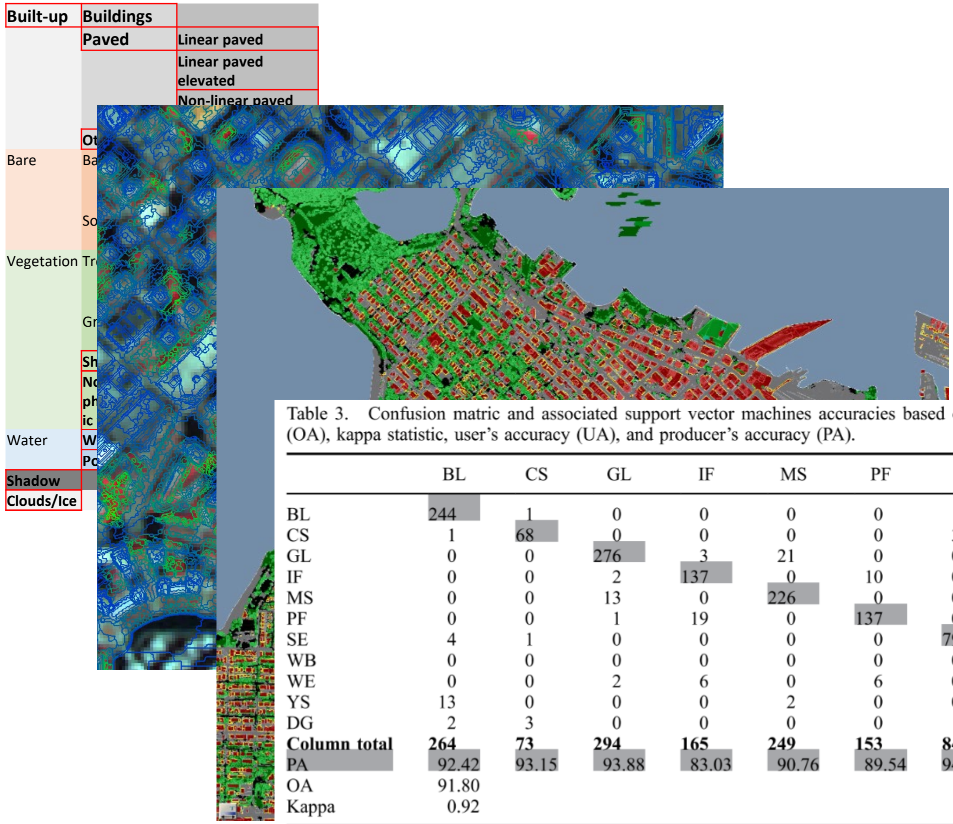




Table 3. Confusion matric and associated support vector machines accuracies based on independence test data set. The accuracies include: overall accuracy (OA), kappa statistic, user's accuracy (UA), and producer's accuracy (PA).

| | BL | CS | GL | IF | MS | PF | SE | WB | WE | YS | DG | Row total | UA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BL | 244 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 8 | 1 | **256** | 95.31 |
| CS | 1 | 68 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | **73** | 93.15 |
| GL | 0 | 0 | 276 | 3 | 21 | 0 | 0 | 0 | 1 | 0 | 0 | **301** | 91.69 |
| IF | 0 | 0 | 2 | 137 | 0 | 10 | 0 | 0 | 2 | 0 | 2 | **153** | 90.13 |
| MS | 0 | 0 | 13 | 0 | 226 | 0 | 0 | 0 | 1 | 2 | 1 | **243** | 93.00 |
| PF | 0 | 0 | 1 | 19 | 0 | 137 | 0 | 0 | 1 | 0 | 0 | **158** | 86.71 |
| SE | 4 | 1 | 0 | 0 | 0 | 0 | 79 | 0 | 0 | 0 | 1 | **85** | 92.94 |
| WB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 49 | 0 | 0 | 0 | **49** | 98.00 |
| WE | 0 | 0 | 2 | 6 | 0 | 6 | 0 | 0 | 167 | 3 | 0 | **184** | 90.76 |
| YS | 13 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 7 | 198 | 1 | **221** | 89.59 |
| DG | 2 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 76 | **82** | 92.68 |
| **Column total** | **264** | **73** | **294** | **165** | **249** | **153** | **84** | **51** | **179** | **211** | **82** | **1805** | |
| PA | 92.42 | 93.15 | 93.88 | 83.03 | 90.76 | 89.54 | 94.05 | 96.08 | 93.30 | 93.84 | 92.68 | | |
| OA | 91.80 | | | | | | | | | | | | |
| Kappa | 0.92 | | | | | | | | | | | | |

| | | |
|---|---|---|
| **Built-up** | **Buildings** | |
| | Paved | **Linear paved** |
| | | **Linear paved elevated** |
| | | **Non-linear paved features** |
| | **Other Built** | |
| Bare | Barren | **Natural barren** |
| | | **Modified barren** |
| | | **Linear unpaved** |
| | Soil | **Natural soil** |
| | | **Modified soil** |
| Vegetation | Tree canopy | **Coniferous** |
| | | **Deciduous** |
| | | **Mixed** |
| | Grass-herb | **Modified grass-herb** |
| | | **Natural grass-herb** |
| | **Shrub** | |
| | **Non-photosynthetic vegetation** | |
| Water | **Water** | |
| | **Pool** | |
| **Shadow** | | |
| **Clouds/Ice** | | |

# MetroVan 2014 Class Definitions

- Classes informed by 2010 landcover classification and literature review
- 3-level hierarchy
- 21 “target” or final classes in total

# Accuracy Assessment: Capturing Rare Cover Types


© Google Earth 2014

- Random points generated within 2010 Landcover layer
  - Stratified random sampling
- Points classified using Google Earth and aerial photos at 1m and 5 m
- Primary and Secondary class assignments

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# How do we deal with change ?

- Change on landscape is relatively small
- T2 – T1 approaches are very poor, when change is a small proportion of land base
  - i.e. 80% accuracy at T1 and T2 .. Yet change is 5%.

- Rather you have an accurate T1 and then monitor for pixels that have changed…
  - Maybe you can monitor using coarser "free" data at least to flag pixels as changed.

# Take Home Message

- Need a high quality base image
  - Augment with LIDAR classes where available
  - Cost ?
- Need agreement on the desired classes / hierarchy
- Need to consider accuracy assessment and how to deal with land cover change

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