Automated Feature Extraction Assessment

Assessment of GA Software and Industry Capability
<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Area Covered</td>
<td>221,079 sqkm</td>
</tr>
<tr>
<td>Land Area Covered</td>
<td>05%</td>
</tr>
<tr>
<td>Dwellings Covered</td>
<td>83%</td>
</tr>
<tr>
<td>Population Covered</td>
<td>72%</td>
</tr>
<tr>
<td>Built-up Areas Covered</td>
<td>99%</td>
</tr>
</tbody>
</table>
NEXIS Methodology

Reference datasets
- COST Factors
- CLUE
- Cadastre
- Business Registry
- Structure LUT
- GNAF
- Census
- GA Survey
- VGO

Geospatial Database
- People
- Buildings
- Infrastructure

Event
- Earthquake, Wind, Tsunami, Flood, Blast, Plume, etc

Hazard Models

Direct Impact
- Business
  - Residential

Casualties
- Injuries
- Fatalities
- Medical costs
Study Area – Launceston, TAS
## Study Area – Lidar Point Cloud

### Metric

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of Interest</td>
<td>16.0 sqkm</td>
</tr>
<tr>
<td>Number of Return Points</td>
<td>67,731,220</td>
</tr>
<tr>
<td>Point Density (all returns)</td>
<td>4.29/sqm</td>
</tr>
<tr>
<td>Point Density (last returns)</td>
<td>3.75/sqm</td>
</tr>
<tr>
<td>Nominal Point Spacing (all returns)</td>
<td>0.48 sqm</td>
</tr>
<tr>
<td>Nominal Point Spacing (last returns)</td>
<td>0.52 sqm</td>
</tr>
<tr>
<td>Scanning Angle</td>
<td>60 degrees</td>
</tr>
<tr>
<td>Flight Speed</td>
<td>234 km/h</td>
</tr>
<tr>
<td>Flight Height</td>
<td>1000 metres</td>
</tr>
<tr>
<td>Scan Rate</td>
<td>95 Hz</td>
</tr>
<tr>
<td>Pulse Rate</td>
<td>240 kHz</td>
</tr>
<tr>
<td>Swath Width</td>
<td>1155 metres</td>
</tr>
<tr>
<td>Swath Overlap</td>
<td>37%</td>
</tr>
</tbody>
</table>
Study Area – Reference Buildings

Desired Data

The objective of this project is to 2D building footprint polygons and their respective building floor, gutter and maximum height attributes from the supplied classified and/or unclassified lidar data.

Producers delivered first parse raw output and a cleaned rectangularised version.
Datasets Assessed

In-House Software

- Geoscience Australia’s Building Geometry Model (BGM)
- CRC-SI’s Barista
- CRC-SI’s Building Footprint Extraction (CRCBFE)
- rapidlasso’s LAStools
- QCoherent’s LP360

External Producers

- Advertised on AusTender
- Received 7 bids
- Engaged 5 producers
Barista
LP360
Example of Produced Dataset
Example of Produced Dataset
Assessment methods

Object-based Assessment

– Evaluation of the presence or absence of spatially-correlated objects

1. Producer’s Accuracy: a measure of completeness
   – Proportion of produced buildings that intersect reference buildings

2. User’s Accuracy: a measure of correctness
   – Proportion of reference buildings that intersect produced buildings

3. Overall Accuracy: a summary of the two previous measures
   – Proportion of above intersecting buildings to total buildings
Assessment results: Object-based

### Producer's Accuracy or completeness
- BGM
- Barista
- LAStools
- LP360 C3 (raw outlines)
- LP360 C3 (squared outlines)
- LP360 (raw outlines)
- LP360 (squared outlines)
- CRC footprint extractor

### User's Accuracy or correctness
- BGM
- Barista
- LAStools
- LP360 C3 (raw outlines)
- LP360 C3 (squared outlines)
- LP360 (raw outlines)
- LP360 (squared outlines)
- CRC footprint extractor

### Overall Accuracy
- BGM
- Barista
- LAStools
- LP360 C3 (raw outlines)
- LP360 C3 (squared outlines)
- LP360 (raw outlines)
- LP360 (squared outlines)
- CRC footprint extractor

Producers:
- Producer 1
- Producer 2
- Producer 3
- Producer 4
- Producer 5
Assessment methods

Horizontal Area-based Assessment
- Evaluation of how well the areas of corresponding datasets coincide on the [X,Y] plane

<table>
<thead>
<tr>
<th></th>
<th>Reference Building</th>
<th>Detected Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Positive (TP)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>False Positive (FP)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>False Negative (FN)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>True Negative (TN)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Positive Measures</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer’s Accuracy</td>
<td>TP/(TP+FN)</td>
</tr>
<tr>
<td>User’s Accuracy</td>
<td>TP/(TP+FP)</td>
</tr>
<tr>
<td>Overall Accuracy</td>
<td>(TP+TN)/(TP+FP+TN+FN)</td>
</tr>
<tr>
<td>Quality Percentage</td>
<td>TP/(TP+FP+FN)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Negative Measures</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area Omission Error</td>
<td>FN/(FN+TP)</td>
</tr>
<tr>
<td>Area Commission Error</td>
<td>FP/(TP+FN)</td>
</tr>
<tr>
<td>Branching Factor</td>
<td>FP/TP</td>
</tr>
<tr>
<td>Miss Factor</td>
<td>FN/TP</td>
</tr>
</tbody>
</table>
Assessment results: horizontal area-based

### Area Omission Error

- **BGM**
- **Barista**
- **LAStools**
- **LP360 C3 (raw)**
- **LP360 C3 (squared)**
- **LP360 (raw)**
- **LP360 (squared)**
- **CRCBFE**

### Area Commission Error

- **BGM**
- **Barista**
- **LAStools**
- **LP360 C3 (raw)**
- **LP360 C3 (squared)**
- **LP360 (raw)**
- **LP360 (squared)**
- **CRCBFE**

### Branching Factor

- **BGM**
- **Barista**
- **LAStools**
- **LP360 C3 (raw)**
- **LP360 C3 (squared)**
- **LP360 (raw)**
- **LP360 (squared)**
- **CRCBFE**

### Miss Factor

- **BGM**
- **Barista**
- **LAStools**
- **LP360 C3 (raw)**
- **LP360 C3 (squared)**
- **LP360 (raw)**
- **LP360 (squared)**
- **CRCBFE**

### Producer's Accuracy

- **BGM**
- **Barista**
- **LAStools**
- **LP360 C3 (raw)**
- **LP360 C3 (squared)**
- **LP360 (raw)**
- **LP360 (squared)**
- **CRCBFE**

### User's Accuracy

- **BGM**
- **Barista**
- **LAStools**
- **LP360 C3 (raw)**
- **LP360 C3 (squared)**
- **LP360 (raw)**
- **LP360 (squared)**
- **CRCBFE**

### Overall Accuracy

- **BGM**
- **Barista**
- **LAStools**
- **LP360 C3 (raw)**
- **LP360 C3 (squared)**
- **LP360 (raw)**
- **LP360 (squared)**
- **CRCBFE**

### Quality Percentage

- **BGM**
- **Barista**
- **LAStools**
- **LP360 C3 (raw)**
- **LP360 C3 (squared)**
- **LP360 (raw)**
- **LP360 (squared)**
- **CRCBFE**
Assessment results: horizontal area-based

Producer's Accuracy
User's Accuracy
Overall Accuracy
Quality Percentage

Area Omission Error
Area Commission Error
Branching Factor
Miss Factor

Producers 1 to 5
Assessment methods

Vertical Area-based Assessment

– Not a definitive quantitative assessment of height attributes, but it provides a relative or qualitative comparison of each dataset
– Heights for the reference dataset were assigned as follows:
  • Floor height: elevation of the DEM at centroid of feature
  • Maximum height: highest building-classified return within feature
  • Gutter height: average of building returns within 1 meter of perimeter
Assessment results: Vertical area-based

Floor Height

Gutter Height

Maximum Height
Conclusion

• Yes you can derive footprints from lidar, depending on your use.
• QA/methodology/consistency of doing it in-house
• We found LAStools to be the best in-house software
  • High accuracy
  • Fully automated
  • Very fast (minutes for AOI)
• Future research into the affect of point density (1-2/sqm)
Jonah Sullivan
Spatial Analyst | National Geographic Information Group
Environmental Geoscience Division | GEOSCIENCE AUSTRALIA
Phone: +61 2 6249 9516   Fax: +61 2 6249 9999
Email: Jonah.Sullivan@ga.gov.au   Web: www.ga.gov.au
Cnr Jerrabomberra Avenue and Hindmarsh Drive Symonston ACT
GPO Box 378 Canberra ACT 2601 Australia
Applying geoscience to Australia’s most important challenges