Mapping Lady Elliot Island

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In February, 2019, the aircraft was in southern Queensland, and the opportunity arose to undertake a lidar and aerial photographic survey of Lady Elliot Island, the most southern cay of the Great Barrier Reef. This was a follow up to research that was undertaken in 2008. The first section below describes the lidar data, while the second concerns the aerial photography.

(a) Lidar data

Accuracy of the lidar is better than 30 cm horizontally and 10 cm vertically (Middleton et al, 2013). Lidar pulses are emitted via a scanning mechanism that provides returns from a swath approximately 250 m wide at 1000 ft altitude. The aircraft flies at approximately 50m/sec, so the lidar will survey approximately 12500 $m^2 . s^{-1}$. Each square meter will have up to 10 points of return, and creating an overlap of all survey swaths will give us 20 points m^{-2}, taken from different angles. This provides penetration through the canopy to lower levels of vegetation and to the ground, allowing estimation of mid level vegetation heights as well as the canopy and ground surface. Flights are conducted along parallel tracks so the surveys cover the island with overlapping swaths to ensure that data density is adequate. The basic ground topography can be deduced from the last lidar return data set, and this is shown in Figure 1.

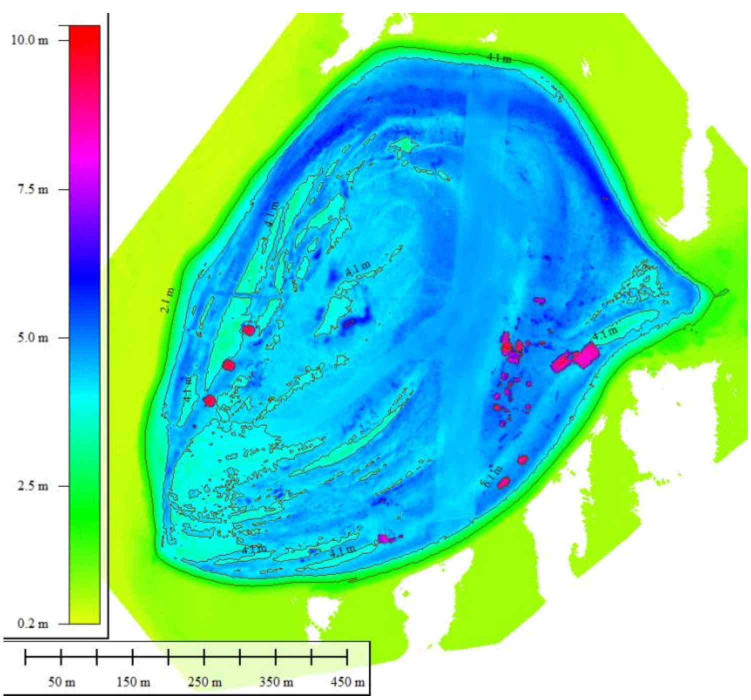

Figure 1. Showing the ground topography above low tide level, which is defined as the set of last lidar returns from the 2019 survey. Buildings are included as they are higher than the ground. The Lighthouses are excluded by the contouring smoothing. The highest topography is about 5m above low tide level.

A false-colour image of the canopy of Lady Elliot as obtained from the first returns is shown in Figure 2. The resort buildings are located on the south-eastern quadrant of the island, and the grass covered runway which is 800m long and 70 m wide runs approximately north-south from beach to beach across the entire island. There is a pedestrian pathway with low grass running from the resort to the south-western side of the island where there are two light-houses, 3 housing structures, and 2 sheds.

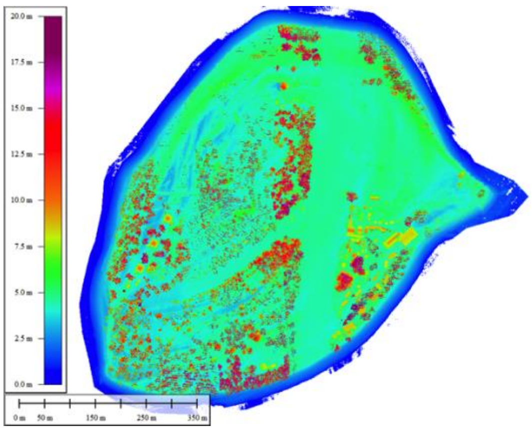

Figure 2a A false colour image of the Lidar returns from an aerial survey of lady Elliot Island. The colour bar at the left shows heights above means sea level.

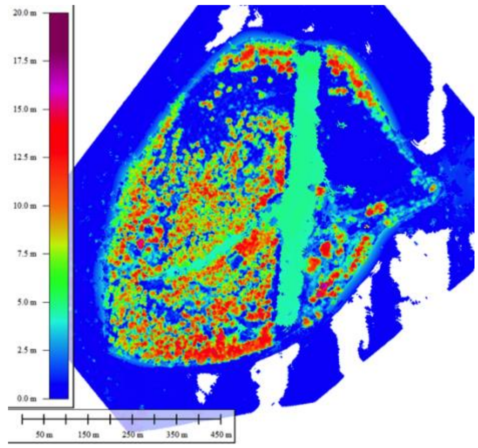

Figure 2b A false colour image of the height of vegetation above the ground. The data in Figure 2b is created by subtracting topographic heights of Figure 1 from Figure 2.

The colour bar indicates heights in metres above sea level. To gain an idea of the nature of the lidar images, a brief description of the vegetation is useful. The tall trees just to the southwest of the swimming pool are old naturally-occurring Pisonia trees and these have a relatively dense top canopy. Other Pisonia trees line the southern edges of the walkway to the west, and these were planted by the Resort owners in the last decade. The northern beaches either side of the runway end are fringed by Casuarina trees, but have extensive Octopus bushes beneath.

The highest point of the island is only about 5 m above low water, or 3 m above high tide, and is at the northwest corner of the island. Sandy beaches with relatively smooth contours run from low water to the vegetated area. Changes in these can easily be detected by repeat surveys as have been done a number of times in other places (see for example, Harley et al, 2017). Deducting the ground topography from the canopy heights gives a direct measure of the vegetation heights. This is shown in Figure 2b.

One way of depicting the vegetation density as a function of height is to plot vertical cross-sections of the canopy, and these are shown in Figure 3. The dot point depictions show the heights at which the lidar signals are reflected, and so are a direct measure of the height and density of the vegetation. One east-west cross section runs from the runway east at northern end of the Island, and the other from the lighthouse to the resort.

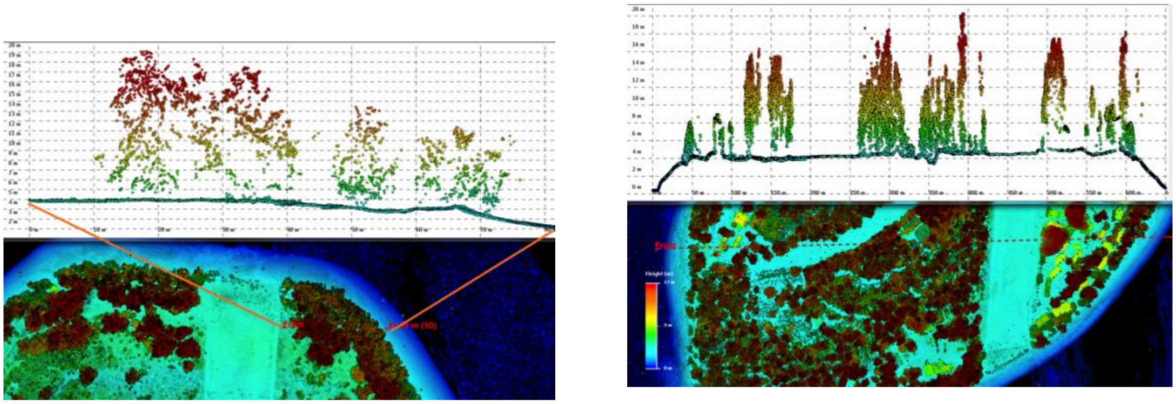

Figure 3. Cross sections of lidar returns at two selected east-west sections, showing vegetation, open areas and the built environment. Trees in the left figure are Casuarina, with a low-density foliage. The solid brown patch of vegetation just east of the Runway in the right image is Pisonia, and the canopy is very dense there.

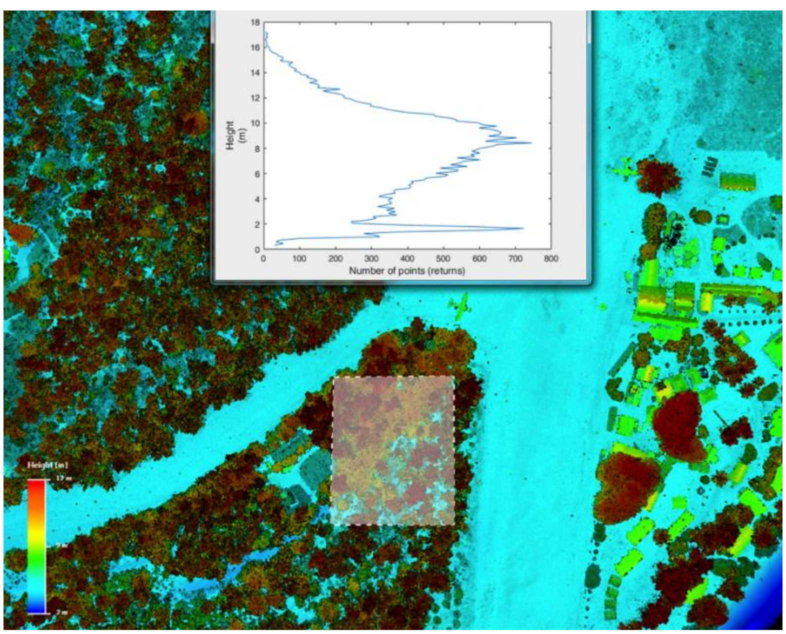

Figure 4. Showing a plot of the vertical changes in density of point returns. This effectively defines the canopy as being most dense at the 8 m level, while there is a secondary maximum of return at the 2 m level where there is another sub-canopy.

For small selected areas, density of returns can be plotted as a function of height, depicting different vegetation levels, and an example of this is shown in Figure 4.

Models of LiDAR data can be supplied in the GeoTIFF format for importing into commonly used GIS software for further analysis and presentation.

b) Photogrammetry data

The canon 50 megapixel camera is operated in such a way that there is overlap between all photographs. A complete and detailed image of the island exists from the 2019 surveys but is of size several hundred gigabytes. Selected screen shots are shown below to demonstrate the resolution and capability.

Figure 5. An aerial photograph showing the area of the cross-section of Figure 4.

Figure 6. An aerial photograph showing the area of cross-section shown in Figure 4.

Figure 7. Showing some of the Lagoon directly east of the resort. Some corals of the lagoon are depicted. Note the size of the boat is approximately 7m in length.

In summary, the combination of lidar and aerial photographs enable a visual and quantitative estimate to be made of the type and extent of habitat. Change in such habitat will be determined by comparison of results from 2019 and 2021.

References

- Middleton J.H., C.G. Cooke; E.T. Kearney; P.J. Mumford, M.A Mole, G.J. Nippard C. Rizos, K.D. Splinter and I.L. Turner (2013) Resolution and accuracy of an airborne scanning laser system for beach surveys, *Journal of Atmospheric and Oceanic Technology*, vol. 30, pp. 2452 - 2464, http://dx.doi.org/10.1175/JTECH-D-12-00174.1
- Harley, M., Turner, I., Kinsela, M., Middleton, J.H., Mumford, P., Splinter, K., Phillips, M., Simmons J., Hanslow, D. and Short A. D. (2017) Extreme Coastal Erosion enhanced by anomalous extra-tropical storm wave direction, *Nature Scientific Reports,* 7: 6033 | DOI:10.1038/s41598-017-05792-1.