

Monitoring River Health in the Murray Darling Basin using High Definition LiDAR - Technical Details

The project comprised of four main parts. Full Wave Form LiDAR acquisition, Four Band Aerial Imagery capture and the GIS processing involved in generating the Physical Form and Vegetation variables. Terranean project managed the overall project and carried out the LiDAR survey, GIS software development subsequent GIS processing to produce the Physical Form and Vegetation variables. Aerometrex and RPS were sub-contracted to carry out the aerial imagery capture and ground survey control respectively.

Extent of the Project

- The project sampled the river channels across the entire 1 million square km Murray Darling Basin
- 70 sites on river channels were randomly generated in each of the 23 Valleys that makes up the Murray Darling Basin.
- Each site consisted of a 2km x 700m rectangular polygon, aligned to the river channel. Primary datasets (DEM, CHM, ortho-mosaic etc) were generated for each site polygon.
- A one kilometer river section was selected within each 2km site. The secondary datasets (bank lines, channel centre line etc) were generated for the 1km river section.
- An average of four check sites were located within each valley. At each check site, clusters of surveyed control points were measured, sampling different types of ground cover. A total of 109 check sites, each containing 20 to 25 surveyed points, produced a total of 2583 check points.

Data Capture

- The accuracy of the LiDAR data and Vexcel imagery were verified using a rigorously designed stratified field survey. Check sites were selected using a three tiered stratification in order to measure the accuracy of the LiDAR in each valley across different land forms and vegetation types. Within each check site, clusters of points were measured to horizontal and vertical accuracies of 0.1m maximum error.
- The full wave-form LiDAR survey parameters were designed to produce a uniform pattern, suitable for statistical analysis of foliage and surface properties. Both along track and across track pulse spacing were set to 0.5m giving a uniform density of 4 pulses per metre within each strip. Two strips were captured for each site with 35% overlap, giving a total density of 6.9 pulses per square metre. Each LiDAR point has a diameter of 0.25 metres.

- Vexcel imagery was captured with a ground pixel spacing of 0.3m.
- Ground control was surveyed to ± 0.1 metre accuracy, both vertical and horizontal. Although this was not demanding in most areas, in some remote parts of the Basin, the geodetic network is of poor quality and this posed some difficulties. Control targets made from core flute were placed where there were insufficient features suitable for control targets.

Data Processing

- The raw LiDAR for each site was adjusted and strip leveled using standard LiDAR processing methods. The LiDAR was then classified into ground, water, vegetation and built structures using a combination of automated and manual methods. The classified LiDAR was clipped to the site polygon and subject to thorough quality checking.
- The Vexcel imagery was rectified against the DEM generated from the LiDAR, colour balanced and mosaicked. Automated processes were used to batch process these steps and produce RGB and false colour enhancements in jp2000 format.
- The primary LiDAR data sets were generated using an automated batch process developed specifically for the project. The automated generation of these variables is a highly innovative aspect of the project that increased efficiency and guaranteed consistent outputs. This batch process also produced ANZLIC metadata for the LiDAR and Vexcel imagery and ensured consistent naming and data structures. The primary datasets were:
 1. Raw LiDAR strips in LAS format
 2. Classified LAS trimmed to the site polygon
 3. Ground points in ascii text format
 4. Ground + built feature points in ascii text format
 5. Vegetation points in ascii text format
 6. Ground Surface DEM
 7. Ground + Built Surface DEM
 8. Vegetation height surface
 9. Foliage density for 17 strata (eg 10cm – 50cm, 50cm – 1m, etc)
 10. Contours with 0.25m interval
 11. Vexcel imagery
 - multi-spectral red, green, blue, infra-red
 - RGB enhancement
 - False colour infra-red enhancement.
 12. Site polygon boundary
- Water inside the river channels was mapped by manual interpretation of the Vexcel imagery in conjunction with the LiDAR which “sees through” vegetation.
- A tool box was developed to produce and check the secondary variables in semi-automated process. The tool randomly generates 19 transects across the river channel and then locates the top and bottom bank points on each transect using

the geomorphologic “Riley Index”. The tool then maps the top and bottom bank lines between each transect and creates channel polygons and five other polygons in and adjacent to the river channel. The secondary datasets were:

1. Left and Right Top Bank
 2. Left and Right Bottom Bank
 3. Channel Centre line
 4. Left and Right channel polygon
 5. Left and Right Bank polygon
 6. Left and Right Bank polygon plus 25 metre buffer
 7. Left and Right Bank polygon plus 50 metre buffer
- The tool then intersects all the secondary data polygons with a pre European vegetation map to produce a complex polygon layer for each site.
 - The foliage density for all 17 strata was then calculated for each polygon.
 - The tool then produced a set of Vegetation Measurements, a matrix of foliage density by strata and vegetation height for each polygon. A total of 18 variables for each polygon.
 - It also created twenty five geomorphological measurements that characterise the “Physical Form” of the river channel. This step represented a significant innovation as it has shown that it is possible to characterize sedimentary river systems and take detailed geomorphologic measurements that previously would have been performed only by an experienced geomorphologist in the field. Examples of the physical form measurements include:
 - Max elevation
 - Min elevation
 - bank top angles, right channel tops
 - bank top angles, left right channel tops
 - left and right bank top elevation
 - left and right bank bottom elevation
 - bank top angle area
 - length of right bank and left bank
 - cross sectional area (sq m) above the bank angle (left and right)
 - cross sectional area (sq m) below the bank angle (left and right)
 - number of inflections on left and right bank
 - length of left and right bank profile
 - Presence of Water
 - Width of water
 - Width of bed
 - Width of channel
 - Channel Depth

The central success of the project was rapid capture and subsequent translation of highly detailed LiDAR point data into value added geomorphic and ecological information in a form that could be analysed and interpreted by geomorphologists and other scientists.