UNSW SYDNEY | Australia's Global University

Water Research Laboratory | School of Civil & Environmental Engineering

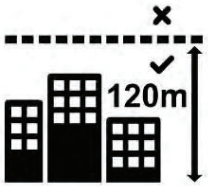
Harnessing drones for water engineering

Chris Drummond- Senior Coastal Engineer and UAS pilot

Case studies:

1. Port Botany Sydney Breakwater inspection
2. Tomago Wetland restoration monitoring
3. Understanding reef lagoon behavior- Cook Islands

Drone Regulations



You must not fly your drone higher than 120 metres (400 feet) above ground level.

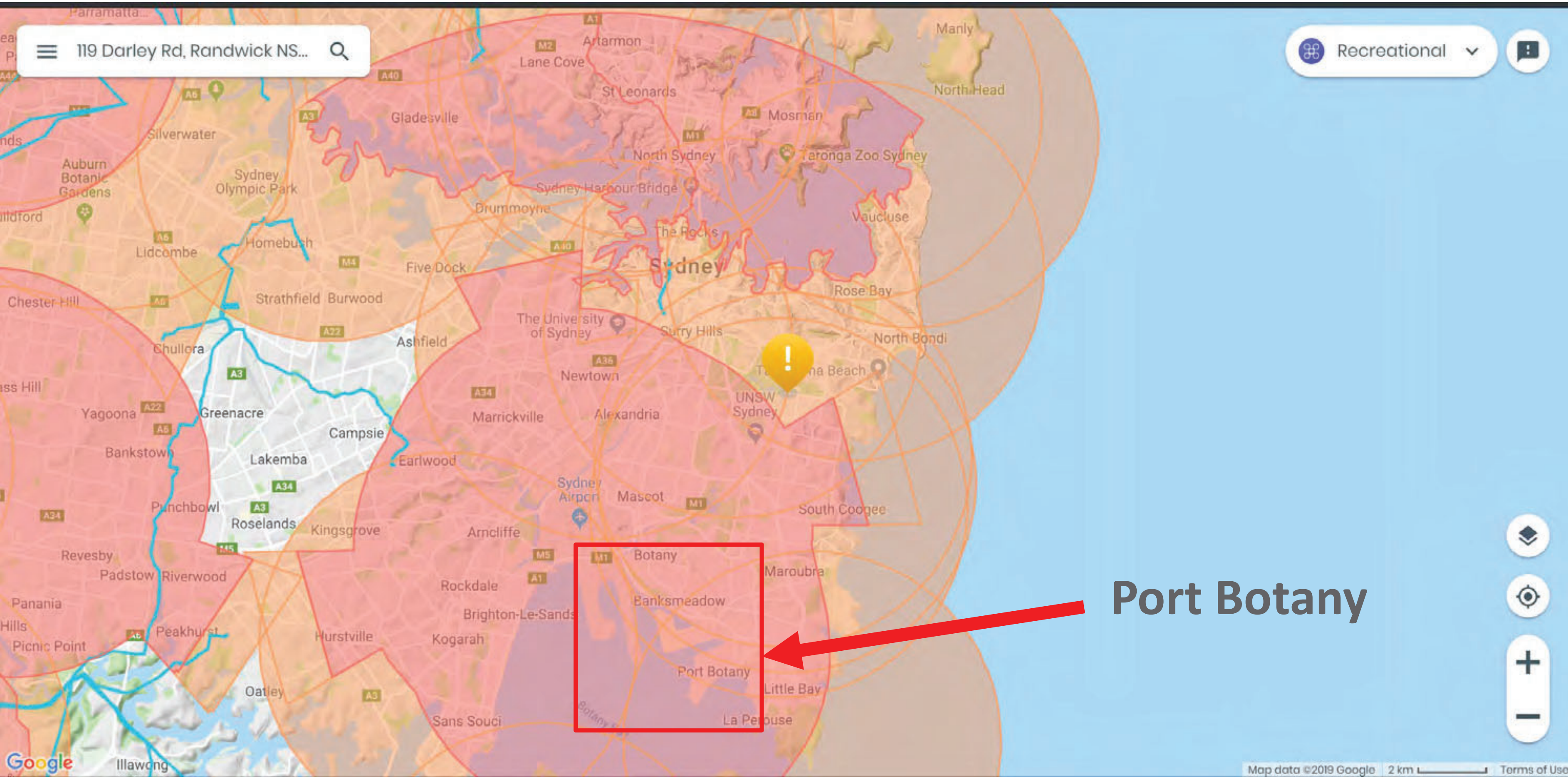
You must keep your drone at least 30 metres away from other people.

You must only fly one drone at a time.

You must keep your drone within visual line-of-sight. This means always being able to see the drone with your own eyes (rather than through a device, screen or goggles).

You must not fly over or above people or in a populous area. This could include beaches, par events, or sport ovals where there is a game in progress.

You must fly at least 5.5 kilometres away from a controlled airport, which generally have a control tower at them.



119 Darley Rd, Randwick NS...
Recreational
Port Botany
Manly
North Head
Artarmon
Lane Cove
St Leonards
Mosman
Gladesville
Silverwater
North Sydney
Taronga Zoo Sydney
Auburn Botanic Gardens
Sydney Olympic Park
Sydney Harbour Bridge
Drummoyne
Vaucluse
The Rocks
Homebush
Lidcombe
Five Dock
Sydney
Rose Bay
Chester Hill
Strathfield
Burwood
The University of Sydney
Surry Hills
Ashfield
North Bondi
Chullora
Newtown
UNSW Sydney
Yagoona
Greenacre
Marrickville
Alexandria
Campsie
Bankstown
Lakemba
Earlwood
Sydney Airport
Mascot
Punchbowl
Roselands
Kingsgrove
Arncliffe
South Coogee
Revesby
Botany
Maroubra
Padstow
Riverwood
Rockdale
Banksmeadow
Panania
Brighton-Le-Sands
Peakhurst
Hurstville
Kogarah
Picnic Point
Little Bay
Oatley
Sans Souci
La Perouse
Illawong
Google
Map data ©2019 Google
2 km
Terms of Use

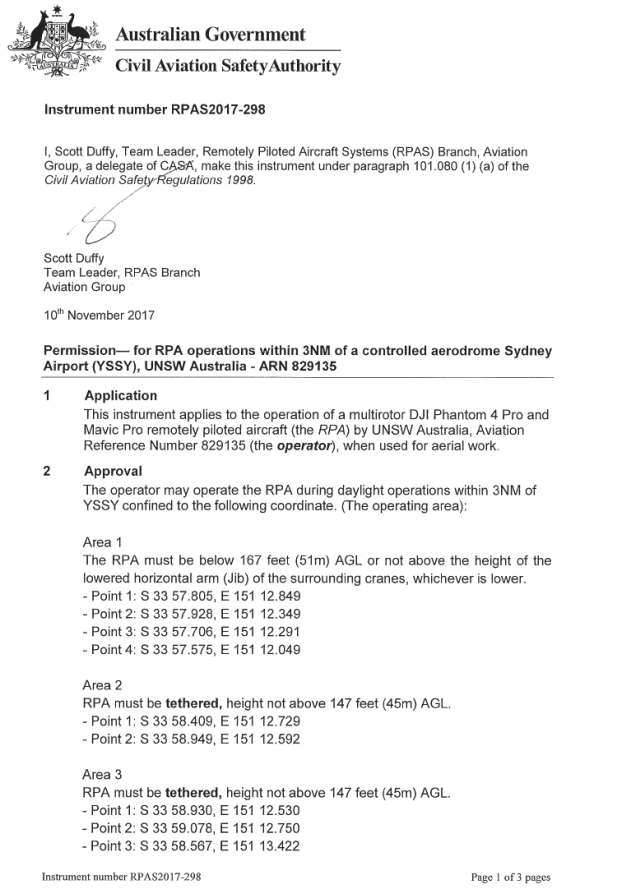
Port Botany, Sydney

- Breakwaters built in 1970s using concrete and rock armour units
- UAS survey for baseline monitoring dataset
- Closest point was ~200 m from runway
- Most congested airspace in Australia
- Lengthy approval process thru CASA

Approval Conditions

1. Drone must stay below 50 m AGL
2. Maintain contact with Sydney Air Traffic Control
3. Use geofencing on drone to prevent a flyaway
4. Notify pilots of drone activity using a NOTAM
5. Have an observer for situational awareness
6. Closure of roads adjacent to survey

7. The drone is to be tethered to the ground at all times



Australian Government
Civil Aviation Safety Authority

Instrument number RPAS2017-298

I, Scott Duffy, Team Leader, Remotely Piloted Aircraft Systems (RPAS) Branch, Aviation Group, a delegate of CASA, make this instrument under paragraph 101.080 (1) (a) of the *Civil Aviation Safety Regulations 1998*.

Scott Duffy
Team Leader, RPAS Branch
Aviation Group

10th November 2017

Permission— for RPA operations within 3NM of a controlled aerodrome Sydney Airport (YSSY), UNSW Australia - ARN 829135

1 Application

This instrument applies to the operation of a multirotor DJI Phantom 4 Pro and Mavic Pro remotely piloted aircraft (the *RPA*) by UNSW Australia, Aviation Reference Number 829135 (the ***operator***), when used for aerial work.

2 Approval

The operator may operate the RPA during daylight operations within 3NM of YSSY confined to the following coordinate. (The operating area):

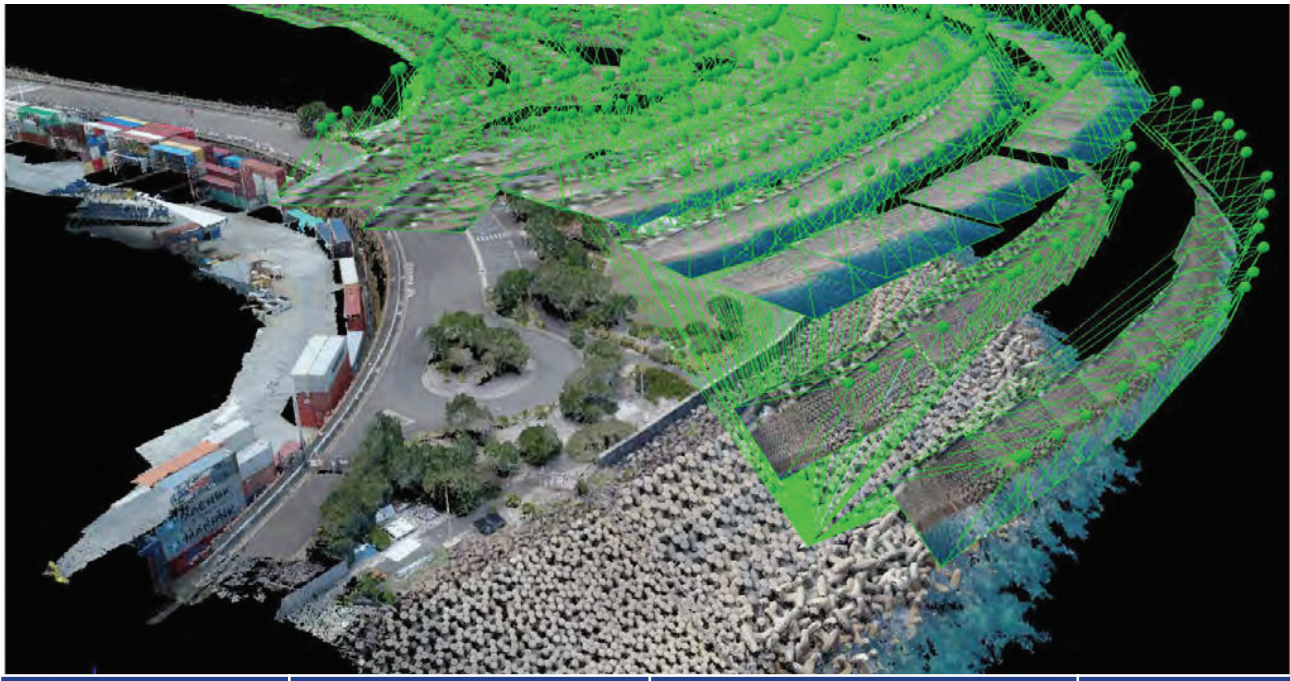
Area 1
The RPA must be below 167 feet (51m) AGL or not above the height of the lowered horizontal arm (Jib) of the surrounding cranes, whichever is lower.
- Point 1: S 33 57.805, E 151 12.849
- Point 2: S 33 57.928, E 151 12.349
- Point 3: S 33 57.706, E 151 12.291
- Point 4: S 33 57.575, E 151 12.049

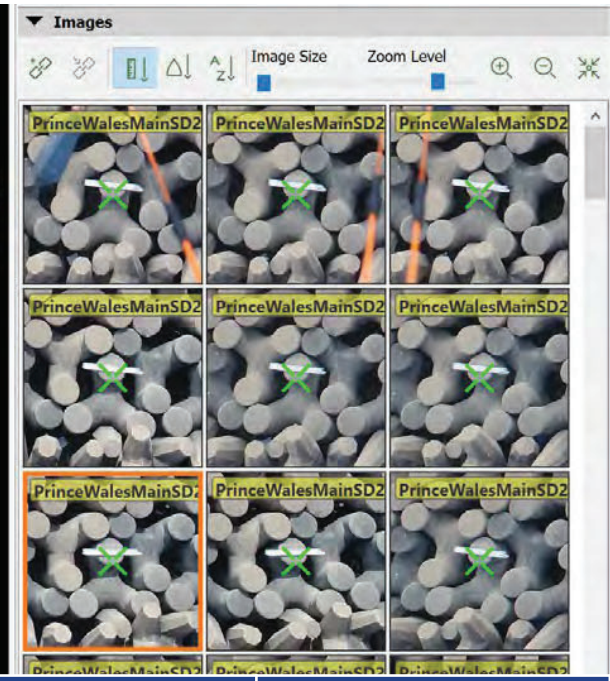
Area 2
RPA must be **tethered,** height not above 147 feet (45m) AGL.
- Point 1: S 33 58.409, E 151 12.729
- Point 2: S 33 58.949, E 151 12.592

Area 3
RPA must be **tethered,** height not above 147 feet (45m) AGL.
- Point 1: S 33 58.930, E 151 12.530
- Point 2: S 33 59.078, E 151 12.750
- Point 3: S 33 58.567, E 151 13.422

Instrument number RPAS2017-298 Page 1 of 3 pages


DRONES ARE NOT PERMITTED
IN THIS PORT AREA BY LAW
NSW Ports
Civil Aviation Safety Authority
Regulations Part 101
NSW Ports
NSW





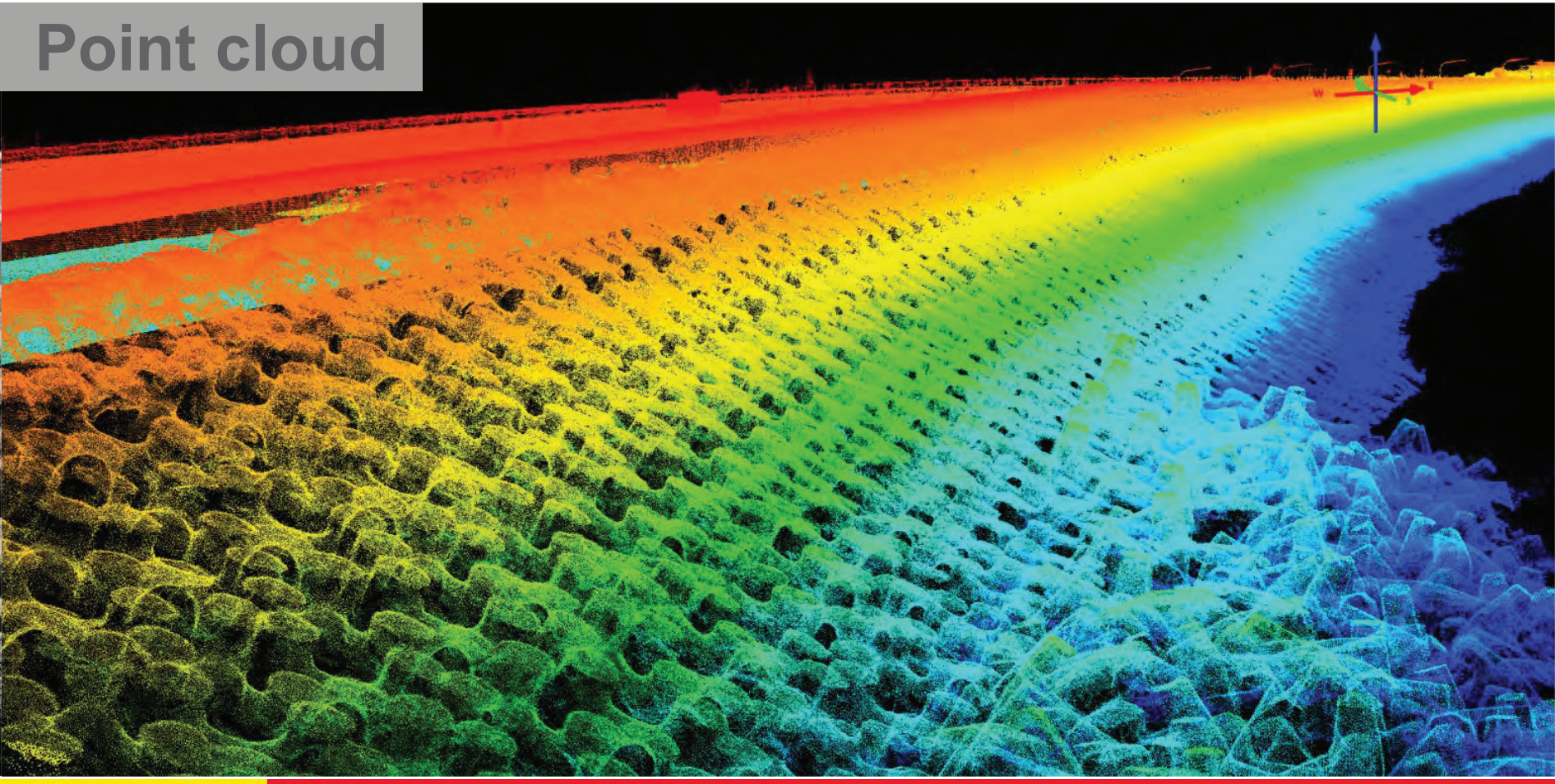
Total photos	Ground sampling distance	Average point density	Number of data points	Processing time
3300	1.22 cm/pixel	922 points/m^2	240 million	2 days

Accuracy validation

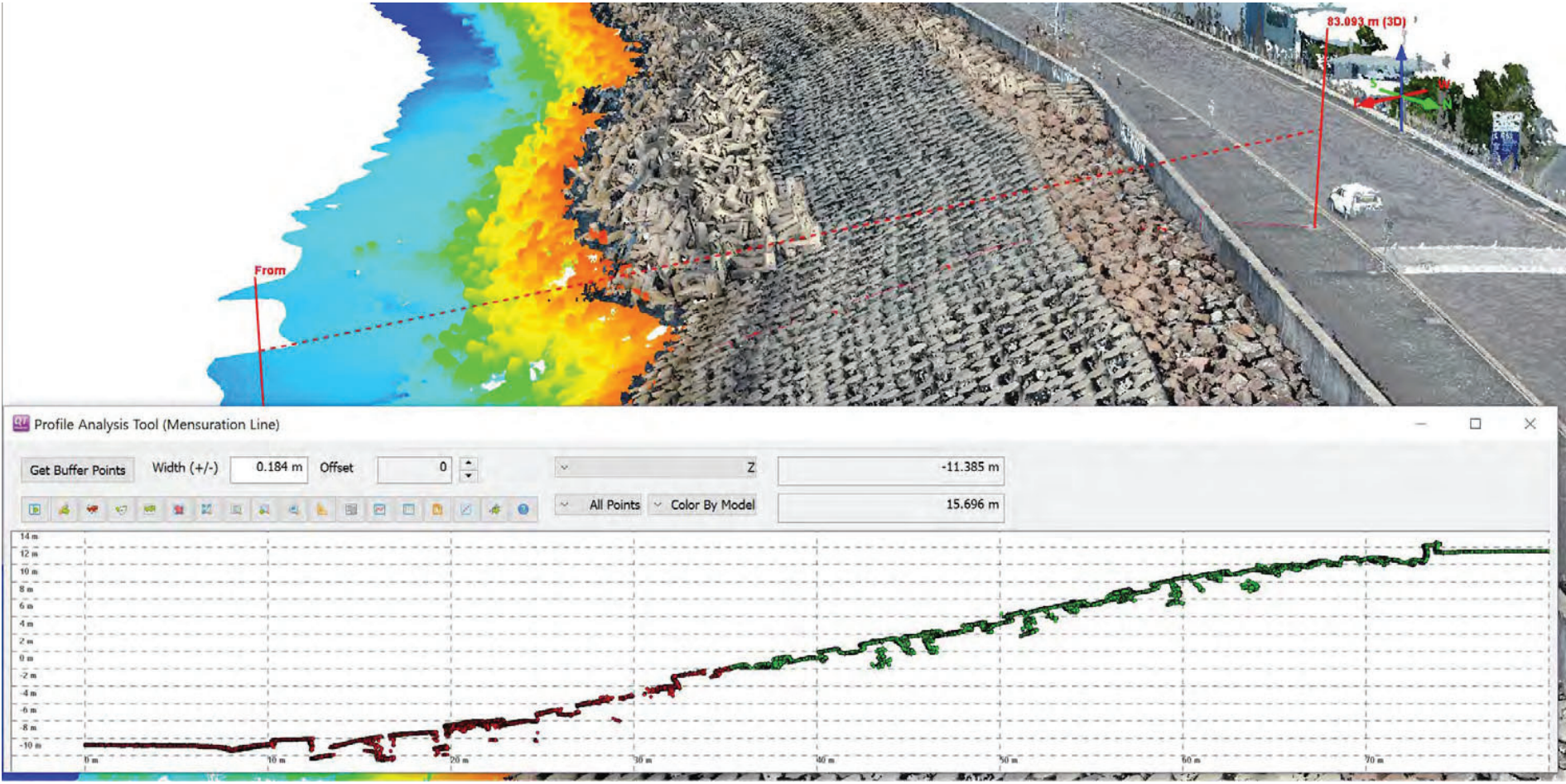
Ground control points

No. GCPs	No. check points	Ground sampling distance (cm/pixel)	Average point density (points/m^2)	RMS X Error (m)	RMS Y Error (m)	RMS Z Error (m)
40	35	1.22 cm/pixel	922 points/m^2	0.02	0.02	0.04

Point cloud



Point cloud


83.093 m (3D)
From
Profile Analysis Tool (Mensuration Line)
Get Buffer Points
Width (+/-)
0.184 m
Offset
0
Z
-11.385 m
All Points
Color By Model
15.696 m
14 m
12 m
10 m
8 m
6 m
4 m
2 m
0 m
-2 m
-4 m
-6 m
-8 m
-10 m
0 m
10 m
20 m
30 m
40 m
50 m
60 m
70 m

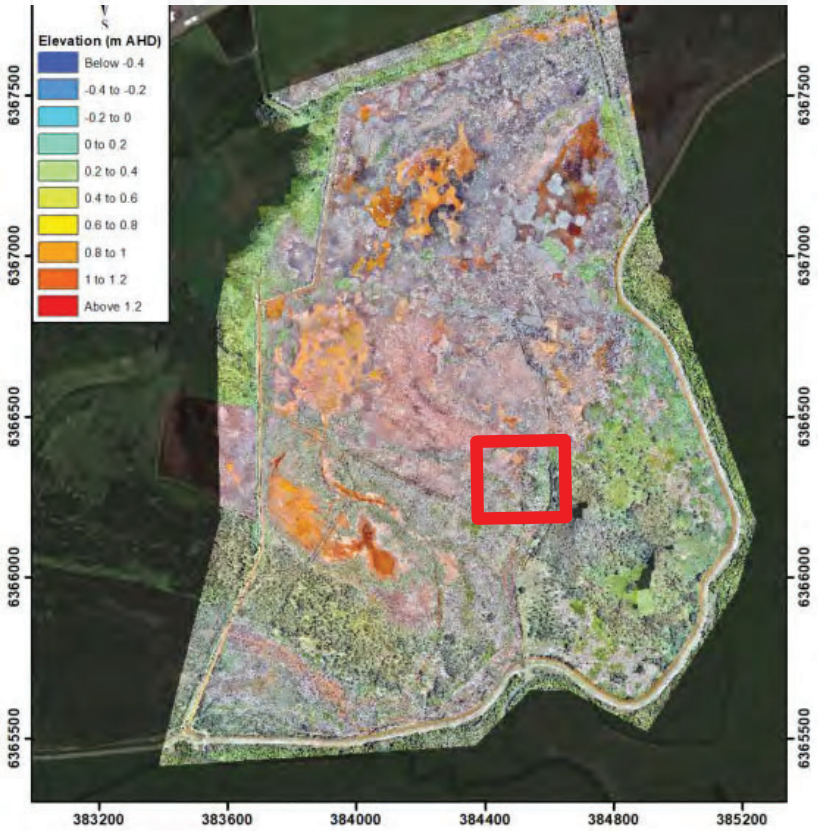
Case studies:

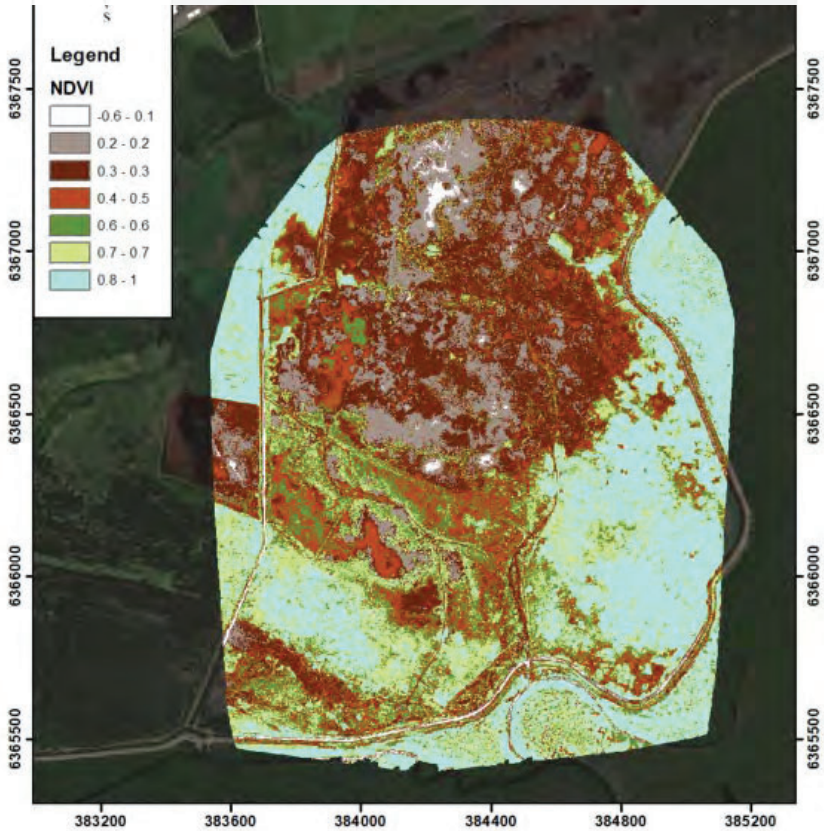
1. Port Botany Sydney Breakwater inspection
2. Tomago Wetland restoration monitoring
3. Understanding reef lagoon behavior- Cook Islands

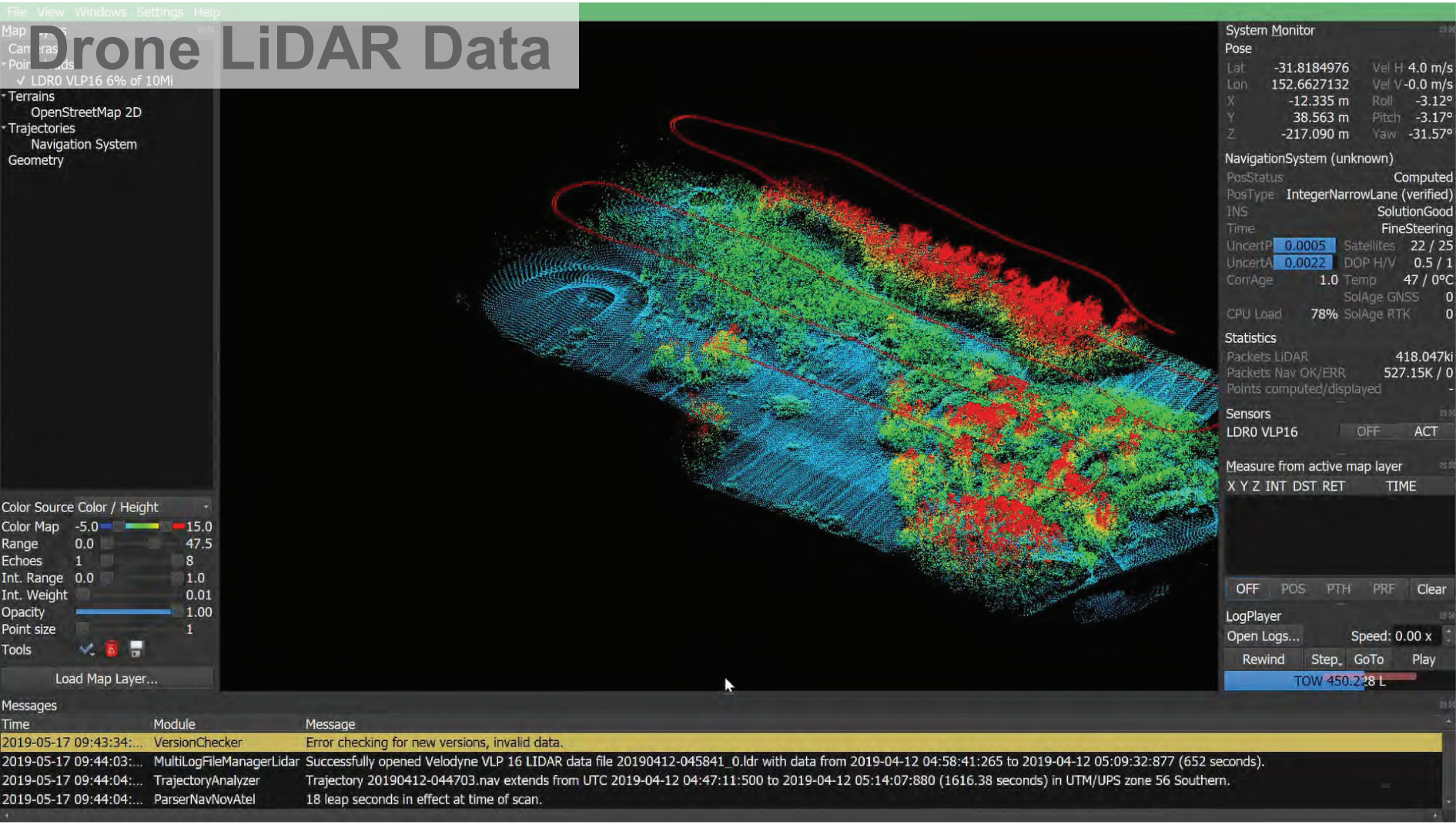
Tomago Wetland Restoration

- 500 Ha site near Newcastle
- Transformed the site from an acidic landscape into a restored tidal wetland
- Detailed hydrodynamic modelling to fine-tune tidal inundation extent
- Ongoing monitoring:
  - Vegetation: Multispectral imagery
  - Elevation: UAS photogrammetry and LiDAR

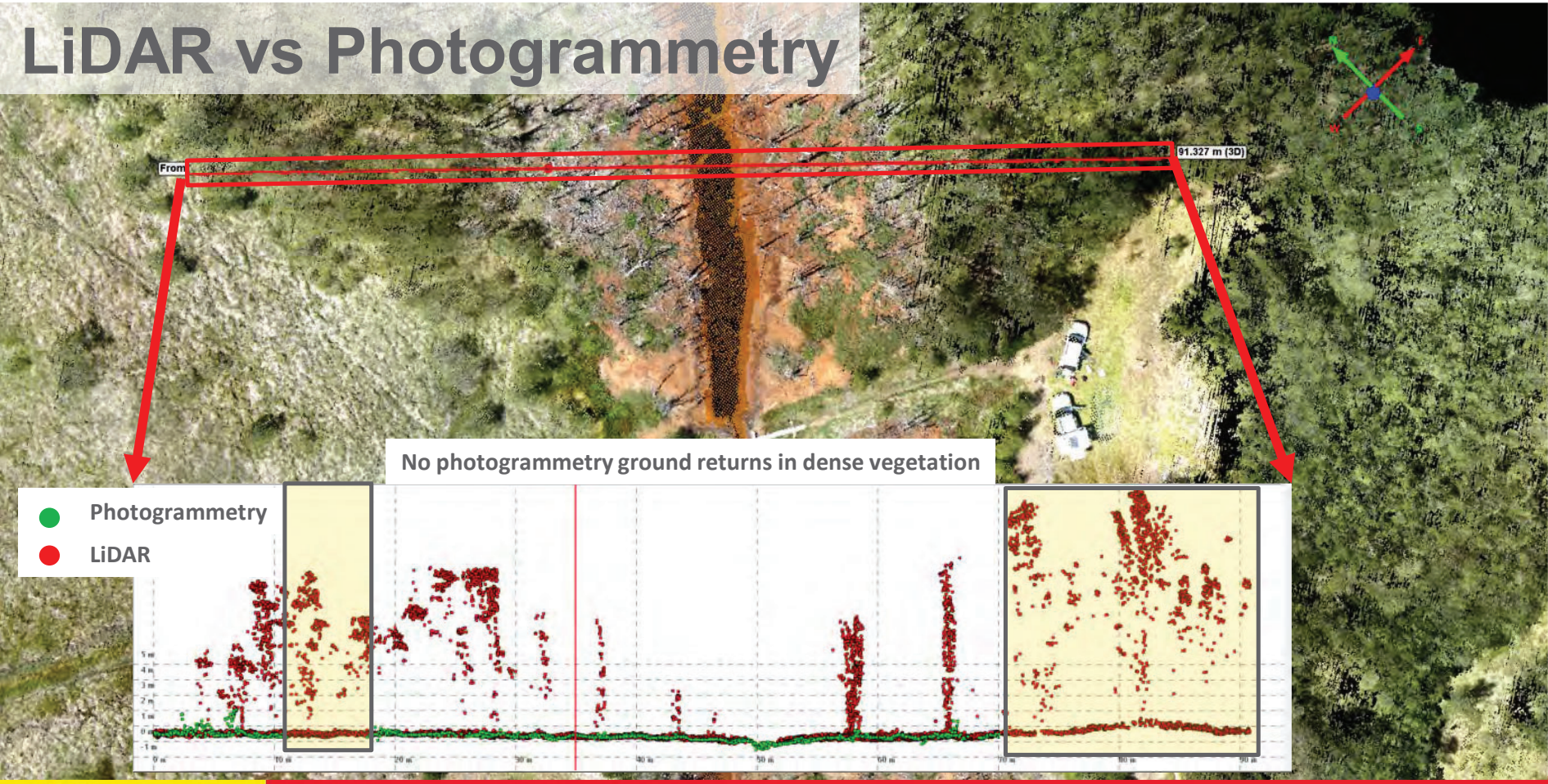
Photogrammetry and multispectral data






File View Windows Settings Help
Drone LiDAR Data
Map
Cameras
Point Clouds
✓ LDR0 VLP16 6% of 10Mi
Terrains
OpenStreetMap 2D
Trajectories
Navigation System
Geometry
Color Source Color / Height
Color Map -5.0 15.0
Range 0.0 47.5
Echoes 1 8
Int. Range 0.0 1.0
Int. Weight 0.01
Opacity 1.00
Point size 1
Tools
Load Map Layer...
System Monitor
Pose
Lat -31.8184976
Lon 152.6627132
X -12.335 m
Y 38.563 m
Z -217.090 m
Vel H 4.0 m/s
Vel V -0.0 m/s
Roll -3.12°
Pitch -3.17°
Yaw -31.57°
NavigationSystem (unknown)
PosStatus Computed
PosType IntegerNarrowLane (verified)
INS SolutionGood
Time FineSteering
UncertP 0.0005
UncertA 0.0022
CorrAge 1.0
Satellites 22 / 25
DOP H/V 0.5 / 1
Temp 47 / 0°C
SolAge GNSS 0
CPU Load 78%
SolAge RTK 0
Statistics
Packets LiDAR 418.047ki
Packets Nav OK/ERR 527.15K / 0
Points computed/displayed -
Sensors
LDR0 VLP16 OFF ACT
Measure from active map layer
X Y Z INT DST RET TIME
OFF POS PTH PRF Clear
LogPlayer
Open Logs...
Speed: 0.00 x
Rewind Step GoTo Play
TOW 450.228 L
Messages
Time Module Message
2019-05-17 09:43:34:... VersionChecker Error checking for new versions, invalid data.
2019-05-17 09:44:03:... MultiLogFileManagerLidar Successfully opened Velodyne VLP 16 LIDAR data file 20190412-045841_0.ldr with data from 2019-04-12 04:58:41:265 to 2019-04-12 05:09:32:877 (652 seconds).
2019-05-17 09:44:04:... TrajectoryAnalyzer Trajectory 20190412-044703.nav extends from UTC 2019-04-12 04:47:11:500 to 2019-04-12 05:14:07:880 (1616.38 seconds) in UTM/UPS zone 56 Southern.
2019-05-17 09:44:04:... ParserNavNovAtel 18 leap seconds in effect at time of scan.

LiDAR vs Photogrammetry



Photogrammetry vs LiDAR

Photogrammetry

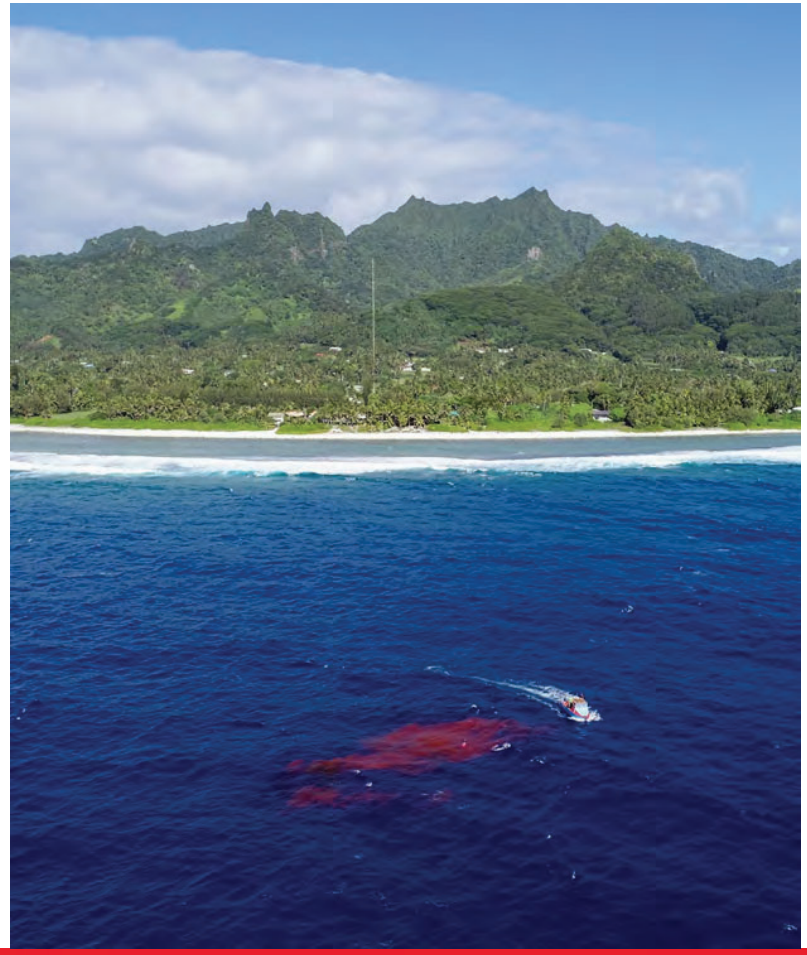
- $8k for drone, ~$7k software
- Provides orthoimage and colourised elevation data (XYZ-RGB)
- Cannot penetrate vegetation
- Can be confused by low texture
- 10 min setup time in field

LiDAR

- $80k-$200k for system
- Can be colourised with additional photogrammetry flight
- Very high point density (600k pts/sec)
- Emerging technology- less plug and play
- Generally higher XYZ accuracy

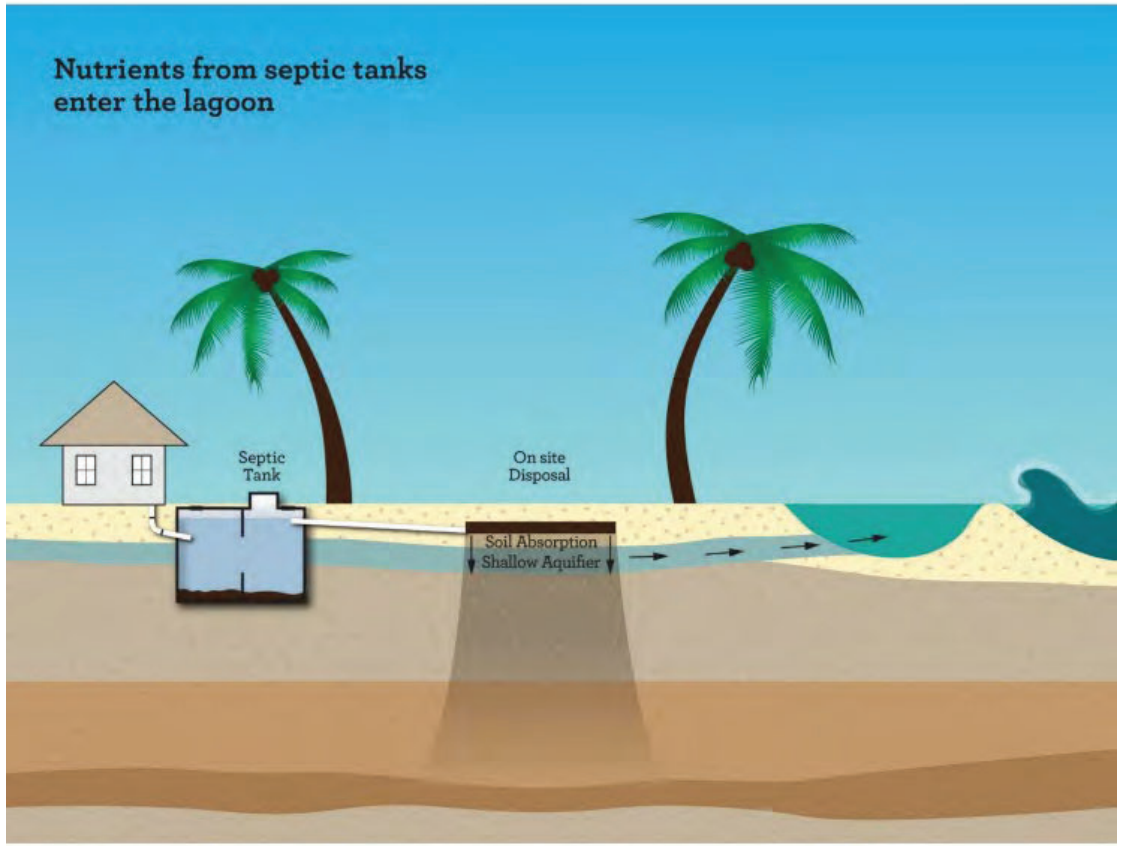
Case studies:

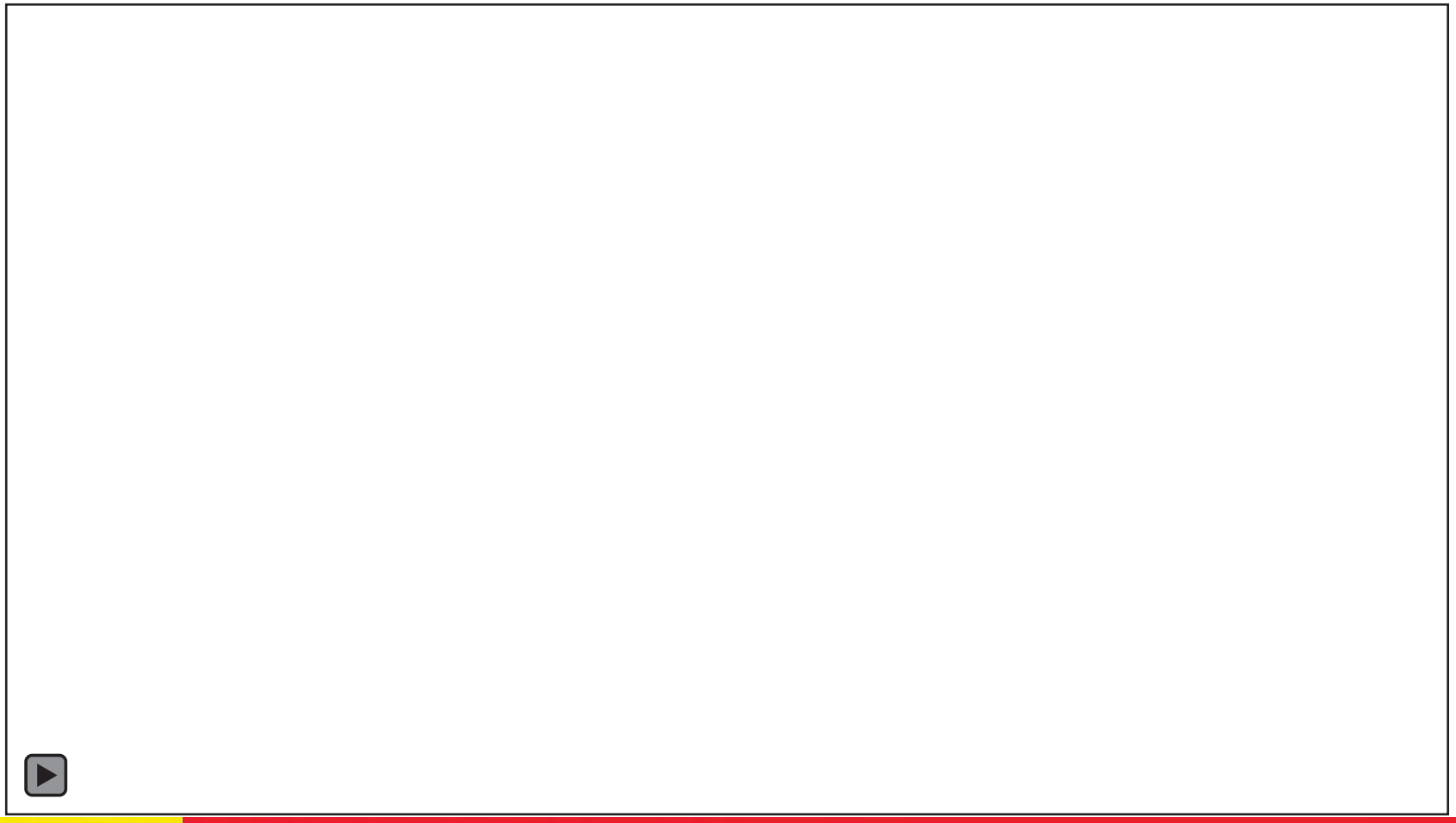
1. Port Botany Sydney Breakwater inspection
2. Tomago Wetland restoration monitoring
3. Understanding reef lagoon hydrodynamics- Cook Islands



The issue

- Current wastewater disposal strategy
- Not enough land to construct a wastewater treatment plant
- Septic tanks being absorbed through sand into lagoon

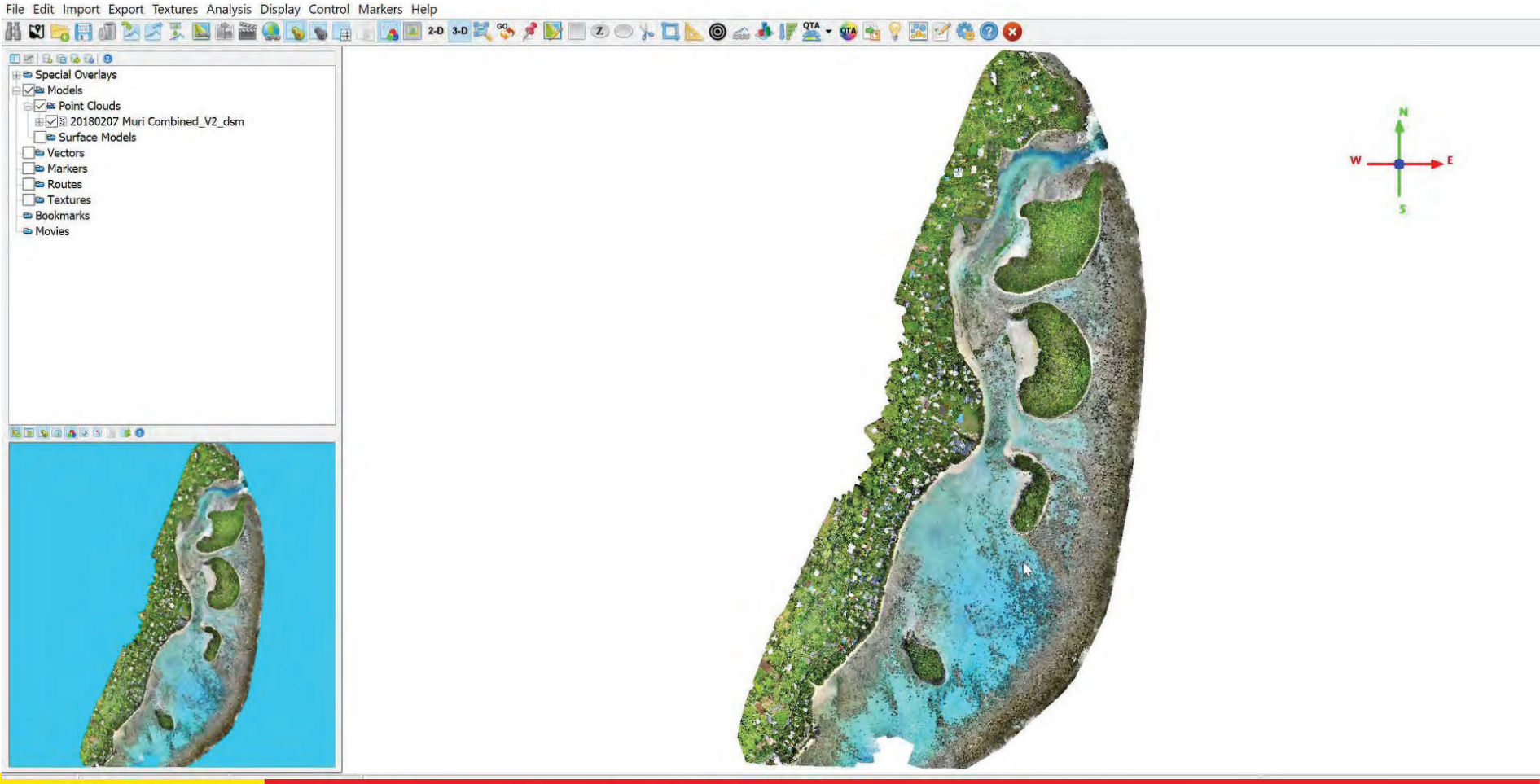




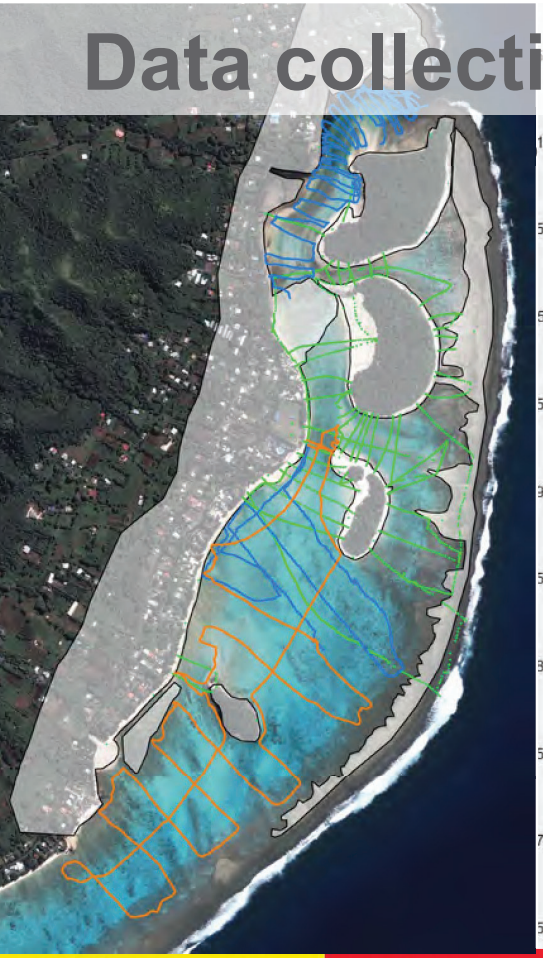
Lagoon Investigations

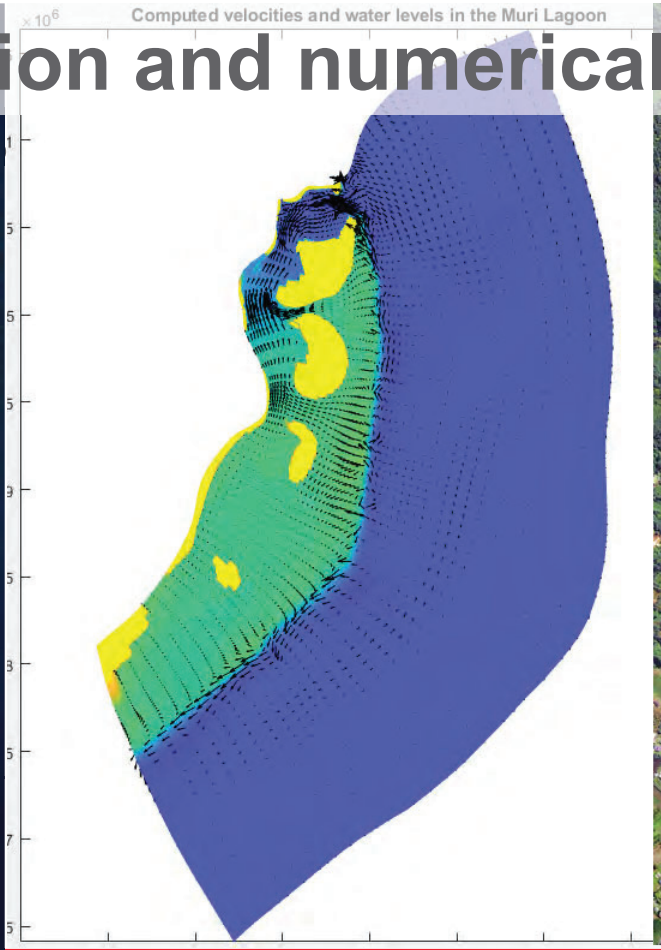
Understand how the lagoon works:

- Drone survey at low tide
- Bathymetric survey
- Measurements of lagoon currents and depth
- Development of hydrodynamic model


File Edit Import Export Textures Analysis Display Control Markers Help
2-D
3-D
Special Overlays
Models
Point Clouds
20180207 Muri Combined_V2_dsm
Surface Models
Vectors
Markers
Routes
Textures
Bookmarks
Movies
N
W
E
S

Data collection and numerical modelling





Watch out for the locals!

UNSW SYDNEY

Water Research Laboratory

School of Civil and Environmental Engineering

Thank you!