

Drones, Lidar and Satellites for 3-D Structure

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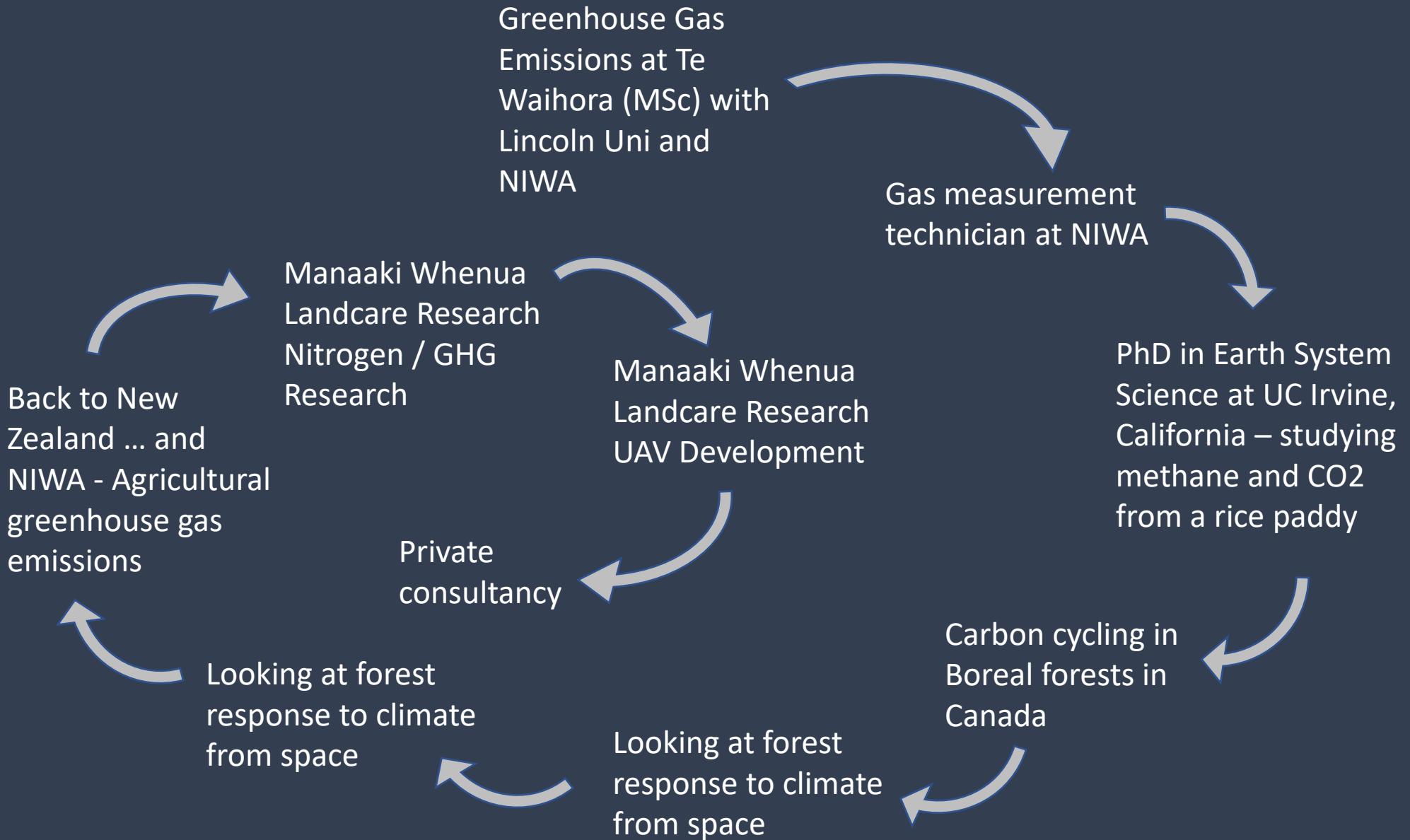
Director, Environmental Analytics NZ Ltd

Director, Land Use Capability Assessments Ltd





How did I become interested in spatial science?





Outline

1. RPAS – Remotely Piloted Aircraft Systems (a.k.a. Drones) – Brief Introduction
2. Today's Use Case – Quantify the Amount of carbon lost through removal of trees using Structure-from-Motion
3. Methods to map topography
4. Practical elements to planning a drone survey
5. Doing a drone survey

Outline

Outline



Learning Goals

Introduction to UAVs

1. Advantages and disadvantages of UAVs as a remote sensing tool

Sensor Types and applications

2. Be able to describe several different sensors and what they are used for

Structure-from-Motion

3. Understand the principal of SFM and the basic steps required to conduct a survey

Waihoanga Exercise

4. Compare SFM versus LiDAR as way of 3d-mapping

Outline

UAVs – a remote sensing tool



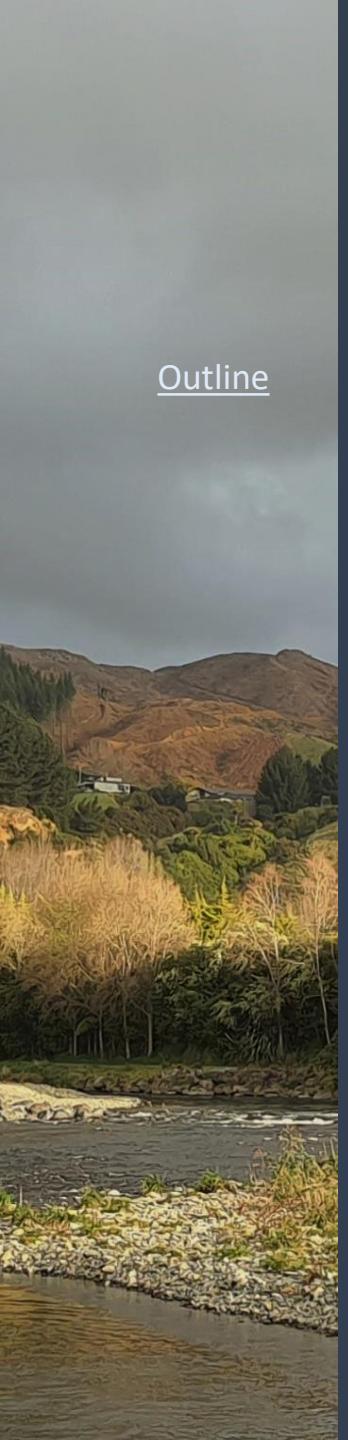
DJI S900 with 20 MP
Sony mirrorless camera



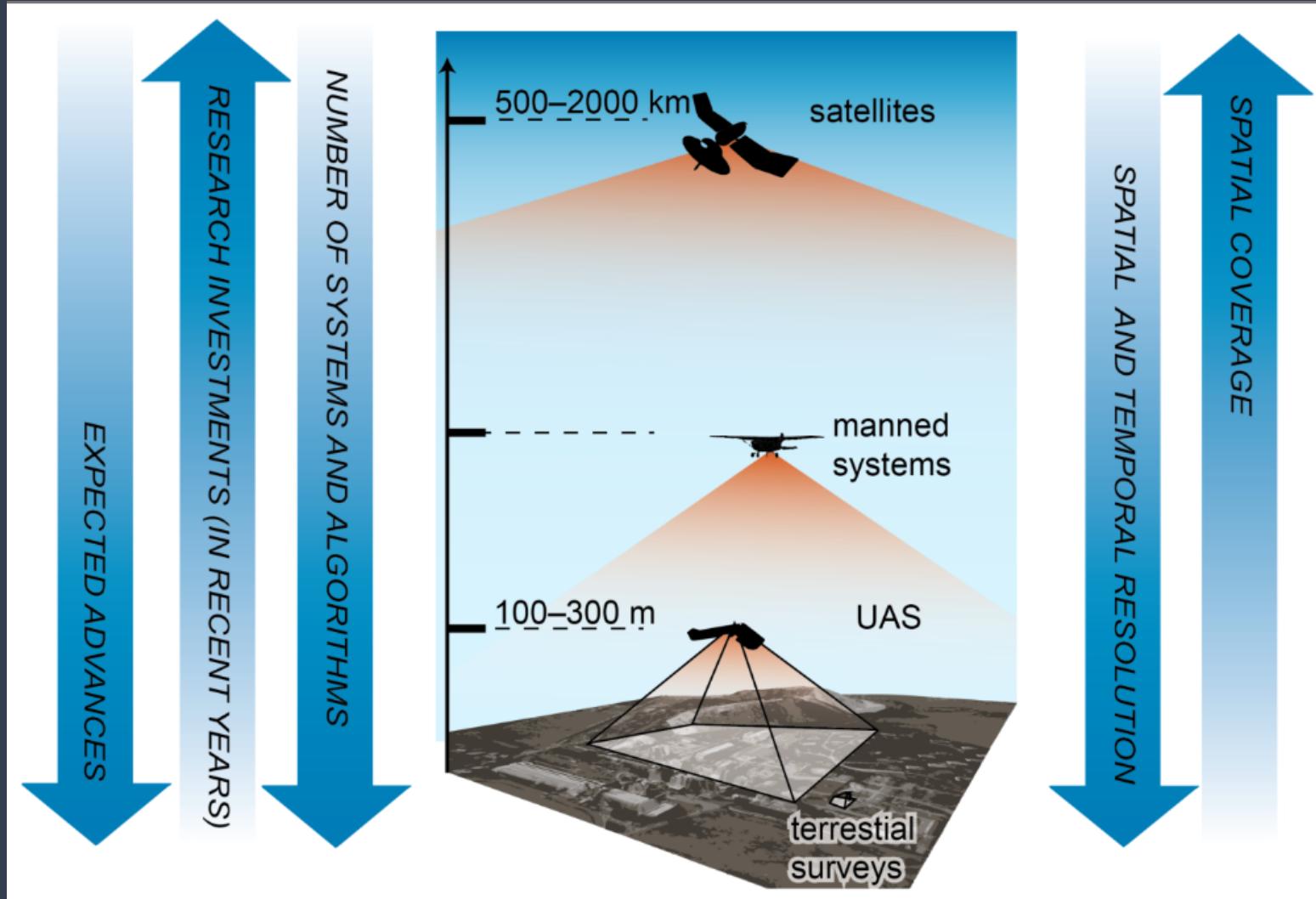
3DR Solo - GoPro

State of Play ca. 2015

Camera not integrated with GPS or drone
GPS needs to be downloaded from



Outline





Advanced imaging equipment for RPAS/UAV Research

2018 Capex Investment by Manaaki-Whenua



Hyperspectral Camera

- DJI M600 Hexacopter with integrated Nano-Hyperspec Hyperspectral Camera and Velodyne VLP-16 Lidar Pod



Fixed Wing RPAS

- Event 38 E384 HD + Sony cameras (20 MP and 40 MP)
- PPK GPS



Multispectral Camera

- Micasense Red-Edge
- multispectral camera



DJI Phantom 4 Advanced

- Professional Grade terrain following photogrammetry RPAS -20 MP camera



Thermal Camera

- St John's Optical
- HD1024 Thermal camera



- Structure-from Motion software – Full License
- Agisoft Photoscan

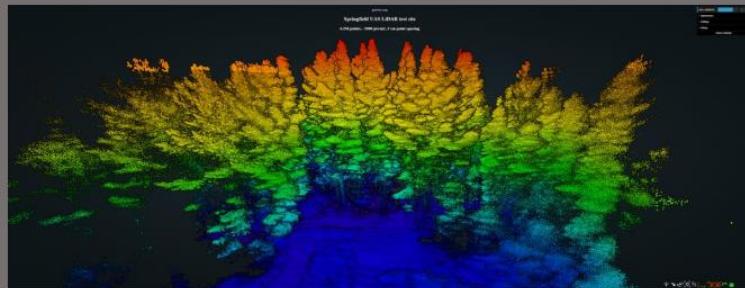
Outline



Waihoanga Exercise

Question: How much carbon was removed with logging of pine trees?

Could structure-from-motion help us?



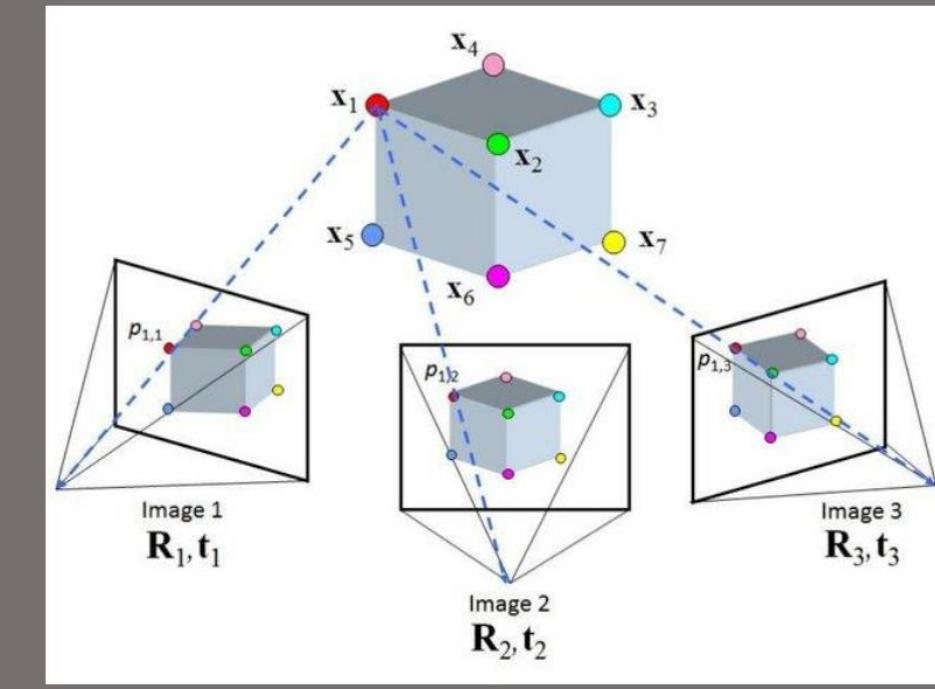
Greater Wellington Lidar Survey



Today Drone Survey

Structure from Motion – a method of photogrammetry

Outline



Ozgur Yilmaz · Fatih Karakus

Stereo and kinect fusion for continuous 3D reconstruction and visual odometry

November 2013

DOI: [10.1109/ICECCO.2013.6718242](https://doi.org/10.1109/ICECCO.2013.6718242)

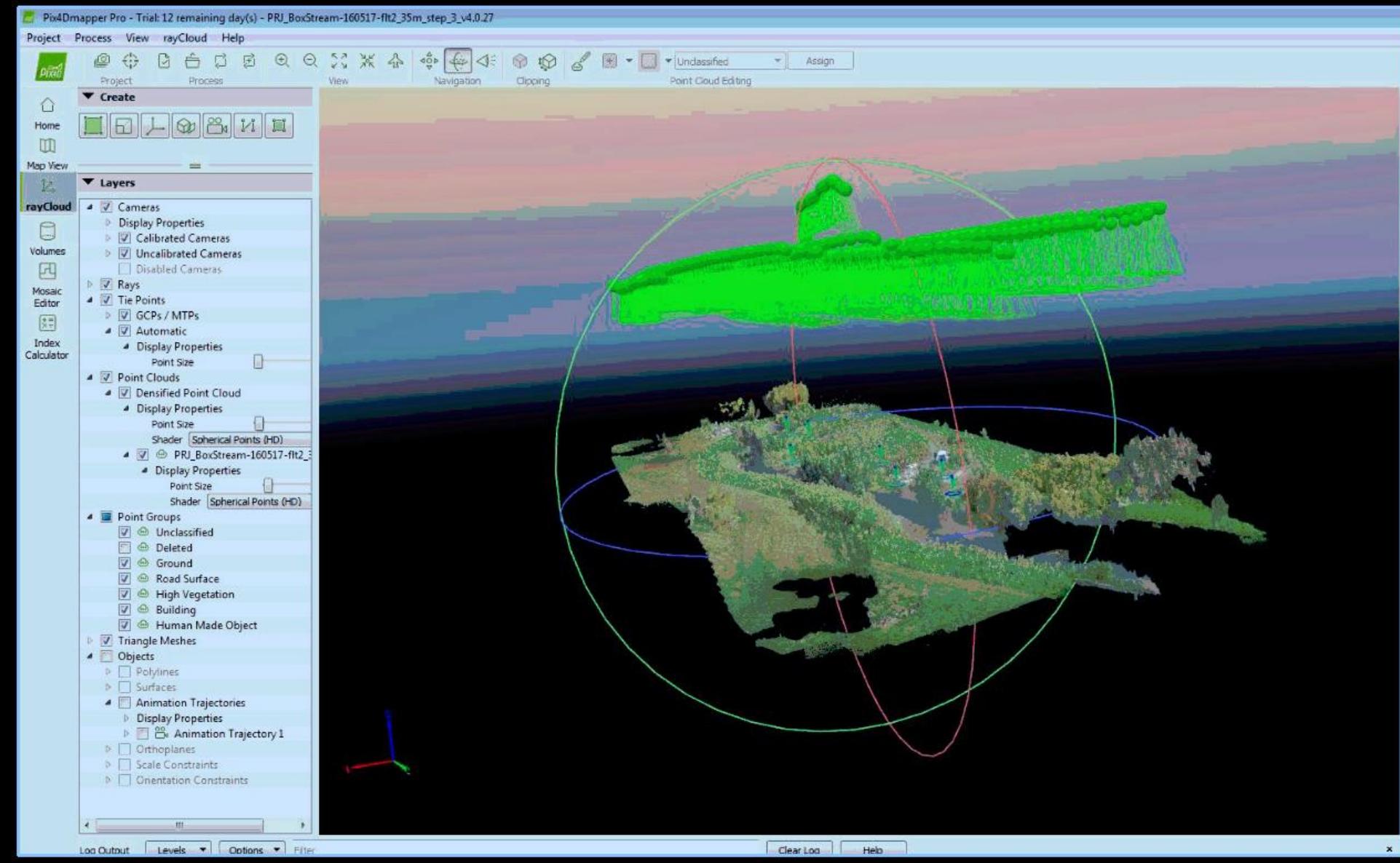
Conference: 2013 International Conference on Electronics, Computer and Computation (ICECCO)

Conference · [International Conference on Electronics Computer and Computation](#)

Structure from Motion – a method of photogrammetry



Construct a 3D model using Structure-from-Motion software





Regulations under Part 101

Line-of-Sight at all times

Max altitude -> 120 m above ground level

Special Permission required for flights within 4 km of aerodrome (unless sheltered), and need certification and a spotter

Don't fly at night

Need permission from property owner or anyone you fly over

Part 102 Certification required for any exception to Part 101. Involved process



Flight Planning

1. Decide on ROI (Region of Interest) GSD (Ground Sampling Distance, ie what resolution is required)
2. Check Visual Navigation Chart – make sure air space is safe and legal. Permissions required.
3. Get reconnaissance –
Download relevant GIS Layers from LINZ – DEM, Orthomosaics, property layer
etc. Is LIDAR available – can import custom DEM to drone software.
4. Flight Survey Planning – Best to do on PC

Massey School of Aviation Course: 2 Day Theory plus 1 day practical test.



CERTIFICATE OF COMPETENCY
REMOTELY PILOTED AIRCRAFT SYSTEMS
Endorsed Multi-Rotor

 MASSEY UNIVERSITY
UNIVERSITY OF NEW ZEALAND

SCHOOL OF AVIATION



PRESNTED TO

Andrew McMillan

The Massey University Certificate of Competency - Remotely Piloted Aircraft Systems, is awarded under the authority of CAA Rule Part 141, Certificate TR32548, to recipients who have completed the Massey University RPAS Course consisting of:

- Introduction to Regulations and Operator Conduct
- Practicum Training introducing the competencies required to pass the Massey University RPAS Flight Test
- RPAS Flight Test for the Massey University RPAS Pilot Certificate


F.S. Sharp
Manager, Professional Programmes

18 January 2017
Presented on this day

Certificate of RPAS Flight Test
This assessment is conducted under the authority of Part 141 Certificate TR 32548

I hereby certify that **Andrew McMillan** has satisfactorily completed the RPAS Flight Test component for the issue of a Certificate of Competency - Remotely Piloted Aircraft Systems in accordance with the Massey University School of Aviation Exposition for:

Multi-Rotor Fixed Wing

Radio Control Mode: 1 2 3 4 GPS
Flight Control Modes: Manual Altitude Hold GPS

(delete if not applicable)

Examiner **Daren Golding** Signed 
Date: **18/1/17**

MSY 040-8 15.10.15

Certificate of RPAS: Introduction to Regulations and Operator Conduct
This assessment is conducted under the authority of Part 141 Certificate TR 32548

I hereby certify that **Andrew McMillan** has satisfactorily completed the RPAS: Introduction to Regulations and Operator Conduct component for the issue of a Certificate of Competency - Remotely Piloted Aircraft Systems in accordance with the Massey University School of Aviation Exposition.

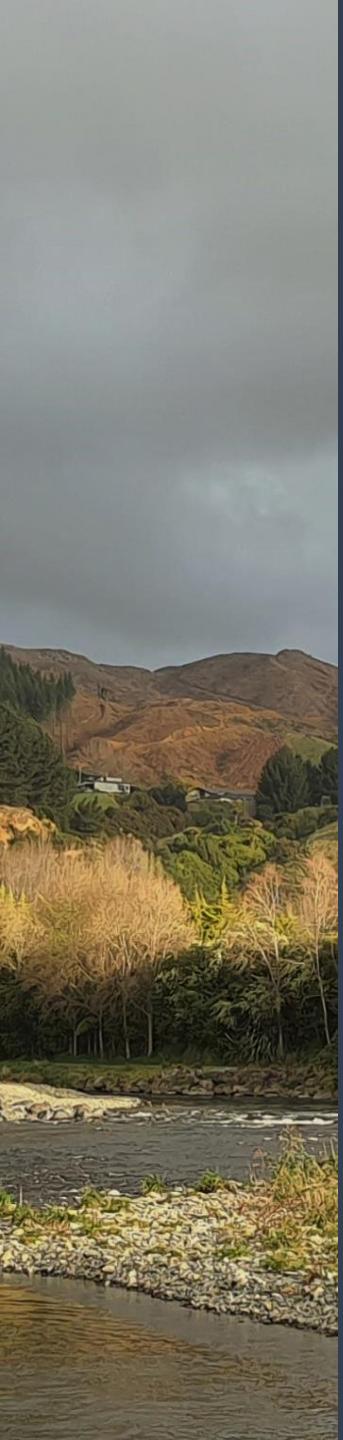
Course Controller **Sam Lamb** Signed 
Date: **3/4/16**

MSY 040-23 02.11.15

Evidence of Qualifications

DJI P4-RTK Flight Planning App





Log your Drone Flights | AirShare Pilot App

airshare.co.nz

Log a Flight Register Menu

Visiting NZ with your Drone?

Read our FAQs



AirShare is the UAV and drone hub for New Zealand.

Here you'll find the information you need to: learn how to operate your drone safely, [plan your drone flights](#), request access to controlled airspace, [download our mobile app](#) and [hire commercial drone operators](#).

Quick quiz
How much do you know about the air rules guidelines?
[Do you need to...](#)

HIRE A DRONE OPERATOR
Find a professional drone operator in New Zealand.

Login to log your flights >
Register and log in to log a flight.

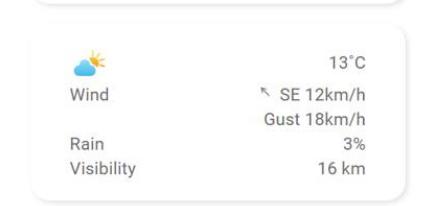


Flight ID: #407058
17 February 2021

Declared

Waihoanga Feb 2021
Pilot: Andrew McMillan

Cancel



Important Information

⚠ Please check your email for further instructions

⚠ AirShare does not:

- Inform uncontrolled aerodromes of your flight
- Inform property owners of your flight
- Inform administering authorities of Military Operating Areas, Restricted Areas etc. of your flight

⚠ Within 4km of an uncontrolled aerodrome:

- Use this app to find the aerodrome phone number and call them directly

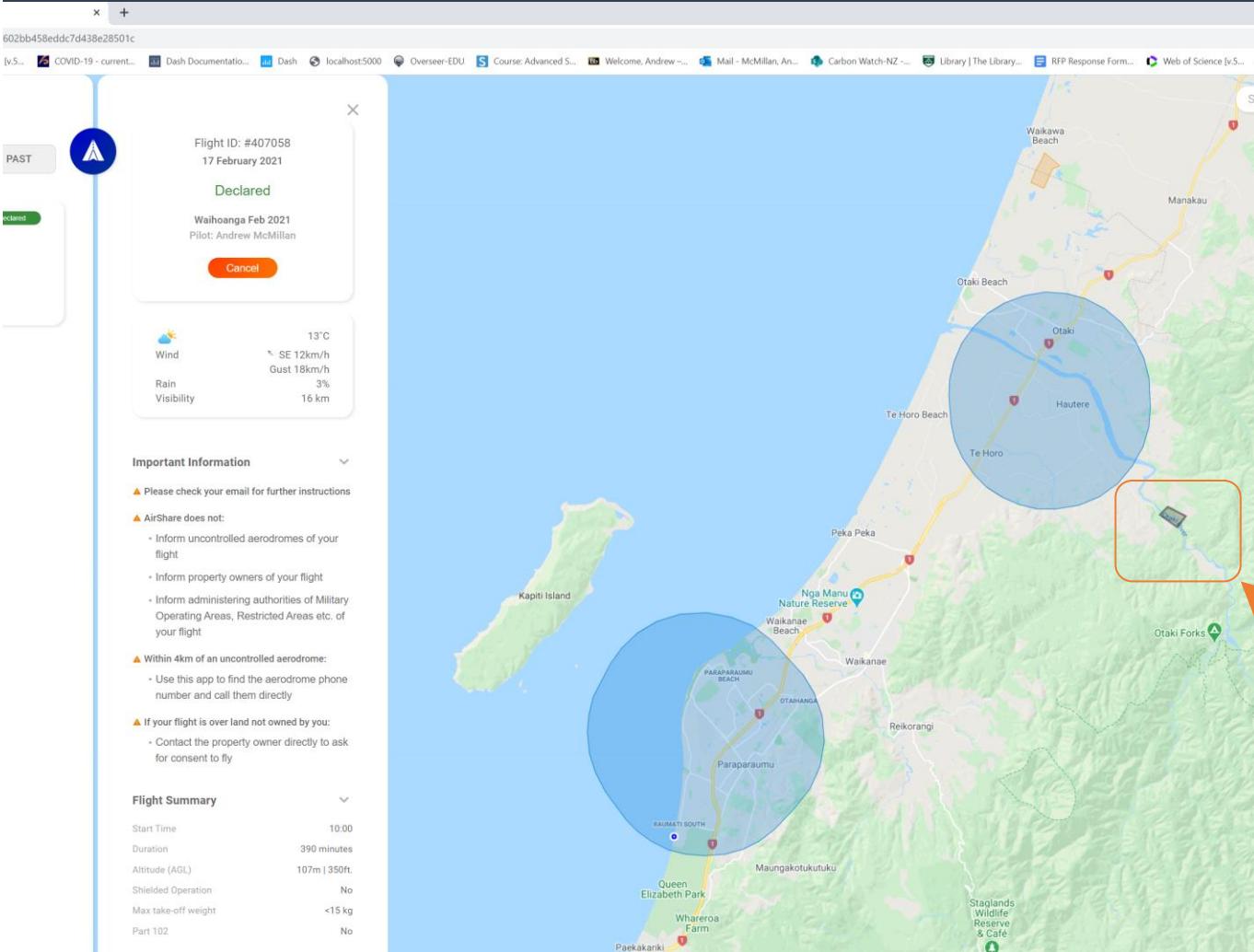
⚠ If your flight is over land not owned by you:

- Contact the property owner directly to ask for consent to fly

Flight Summary

Start Time	10:00
Duration	390 minutes
Altitude (AGL)	107m 350ft.
Shielded Operation	No
Max take-off weight	<15 kg
Part 102	No

Log an AirShare Flight



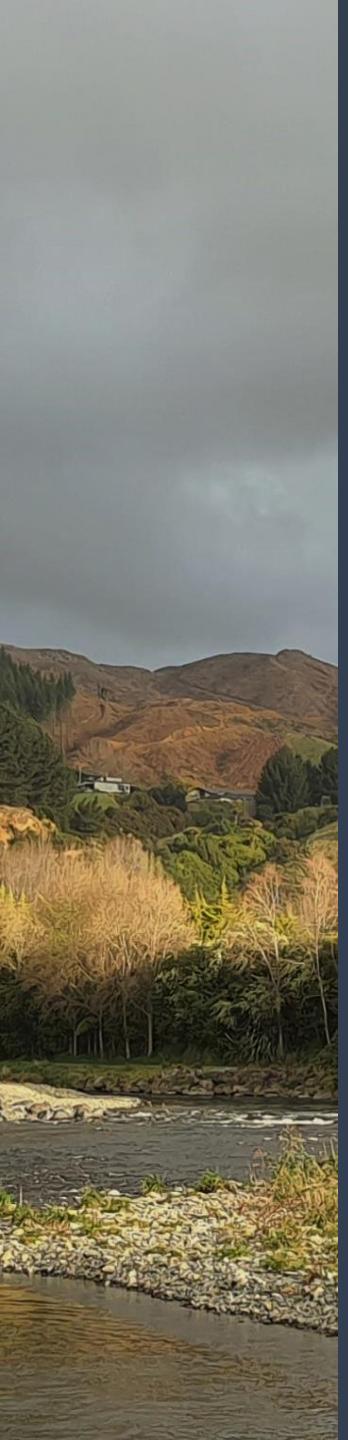
Our flight today

The DJI Flight-Planning App (Controller does not allow 3rd party Appls)





The USgS Flight-Planning App which allows desktop planning and syncs to in the field app



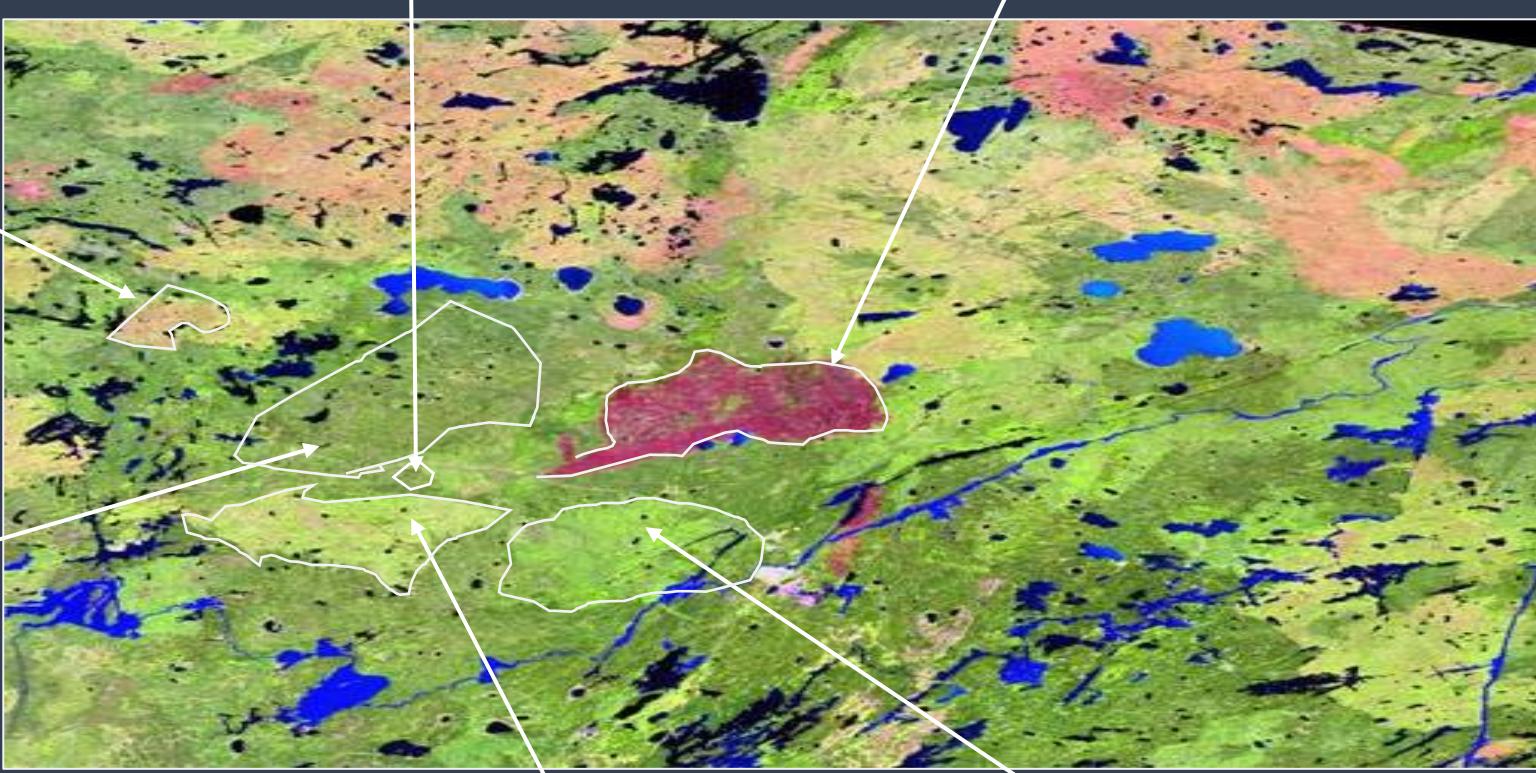
1989 Burn



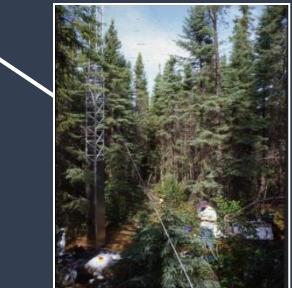
1850 Burn



1981 Burn



1964 Burn



2003 Burn







M2

K2

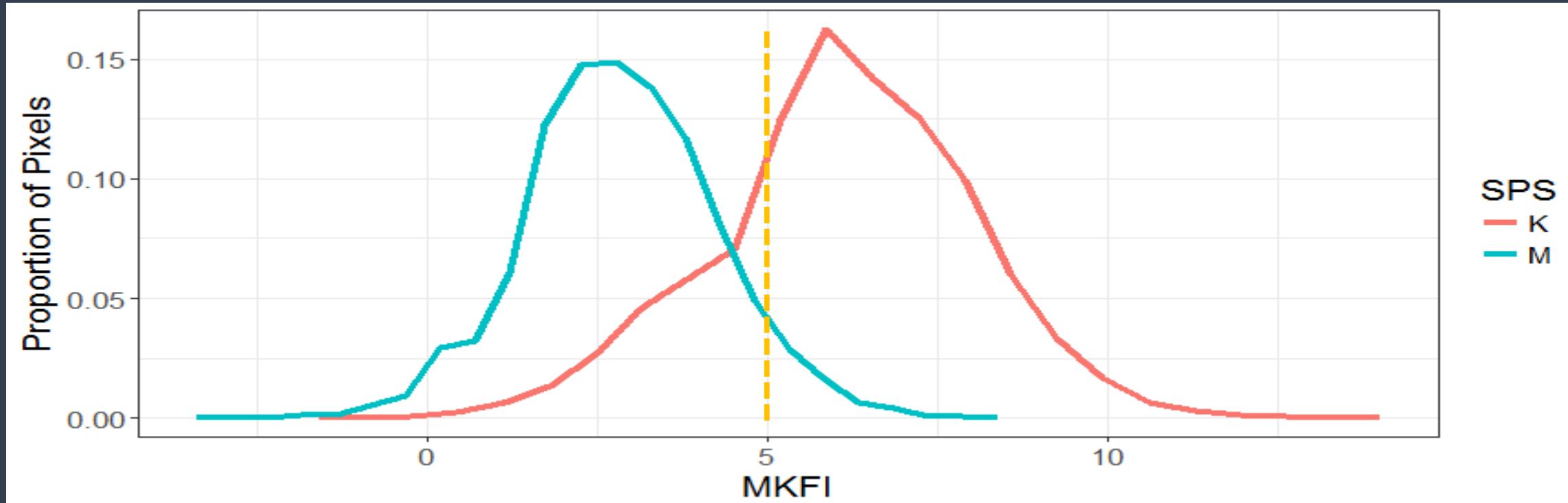
M1

m3

K3

M5

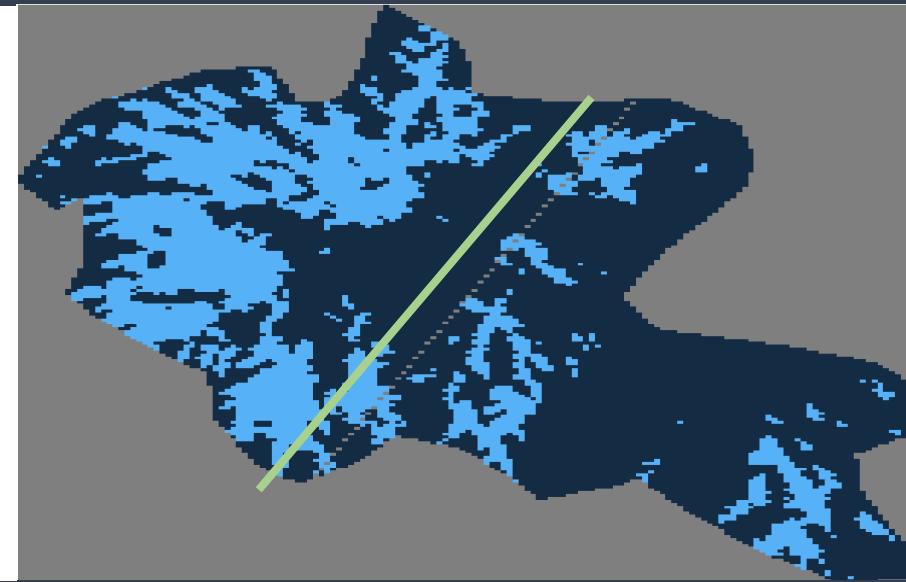
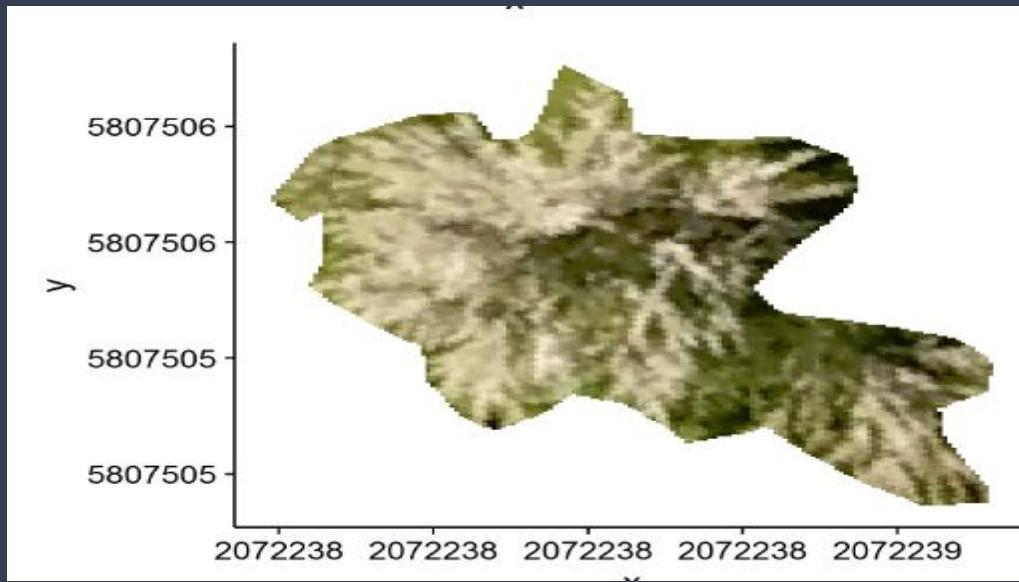
The Manuka-Kanuka Flower Index (MKFI)

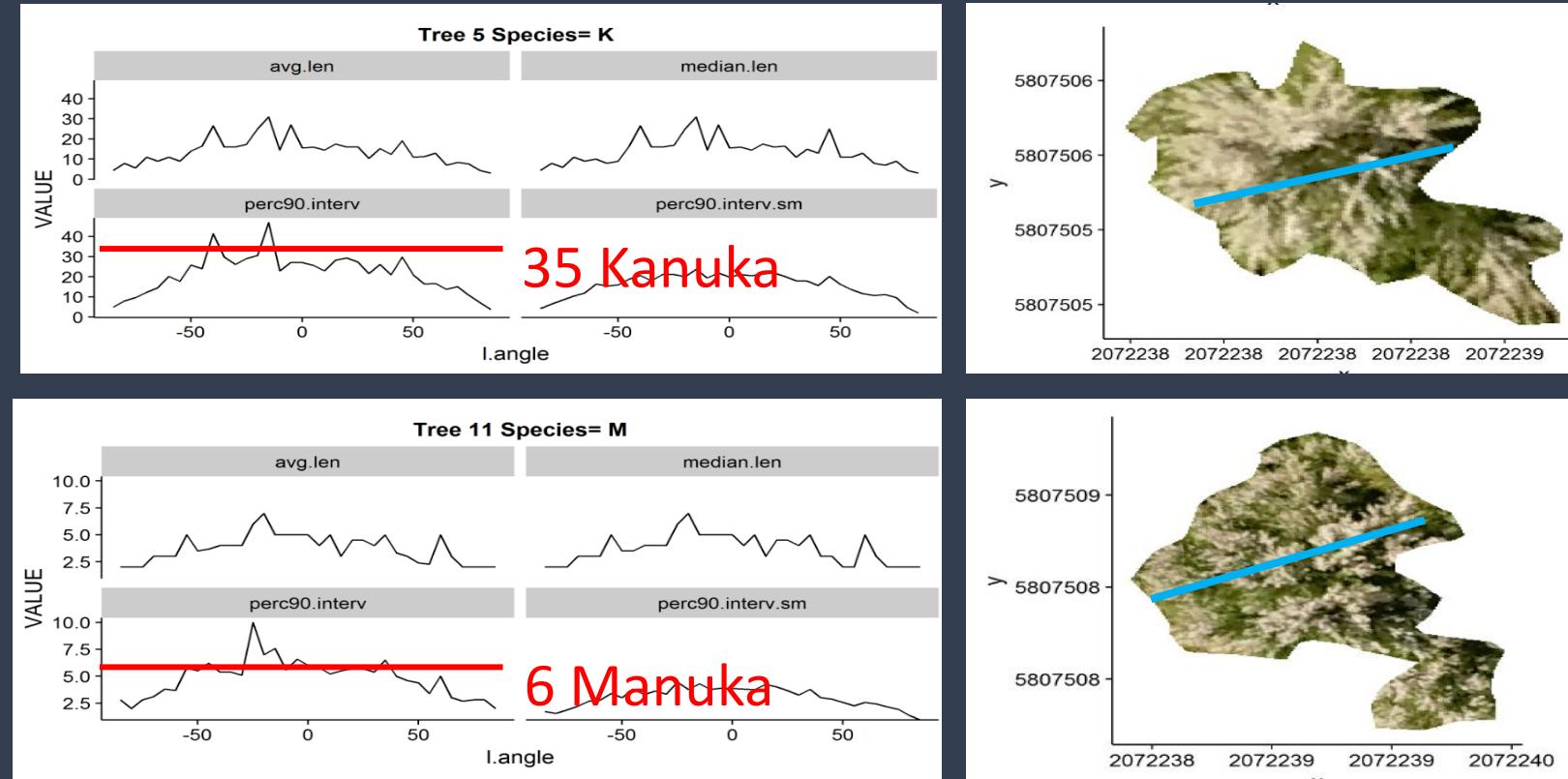


If peak MKFI < 5, then species is Manuka, otherwise Kanuka

90% Accurate on Test Data Set

Look for contiguous Intervals





The streaky factor ... count the streaks in each tree

Outline

Resolution

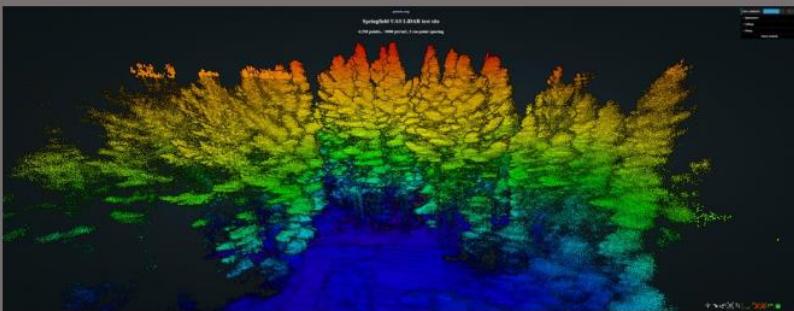
Conventional Aerial Photography and RPAS Imagery



Waihoanga Exercise

Question: How much carbon was removed with logging of pine trees?

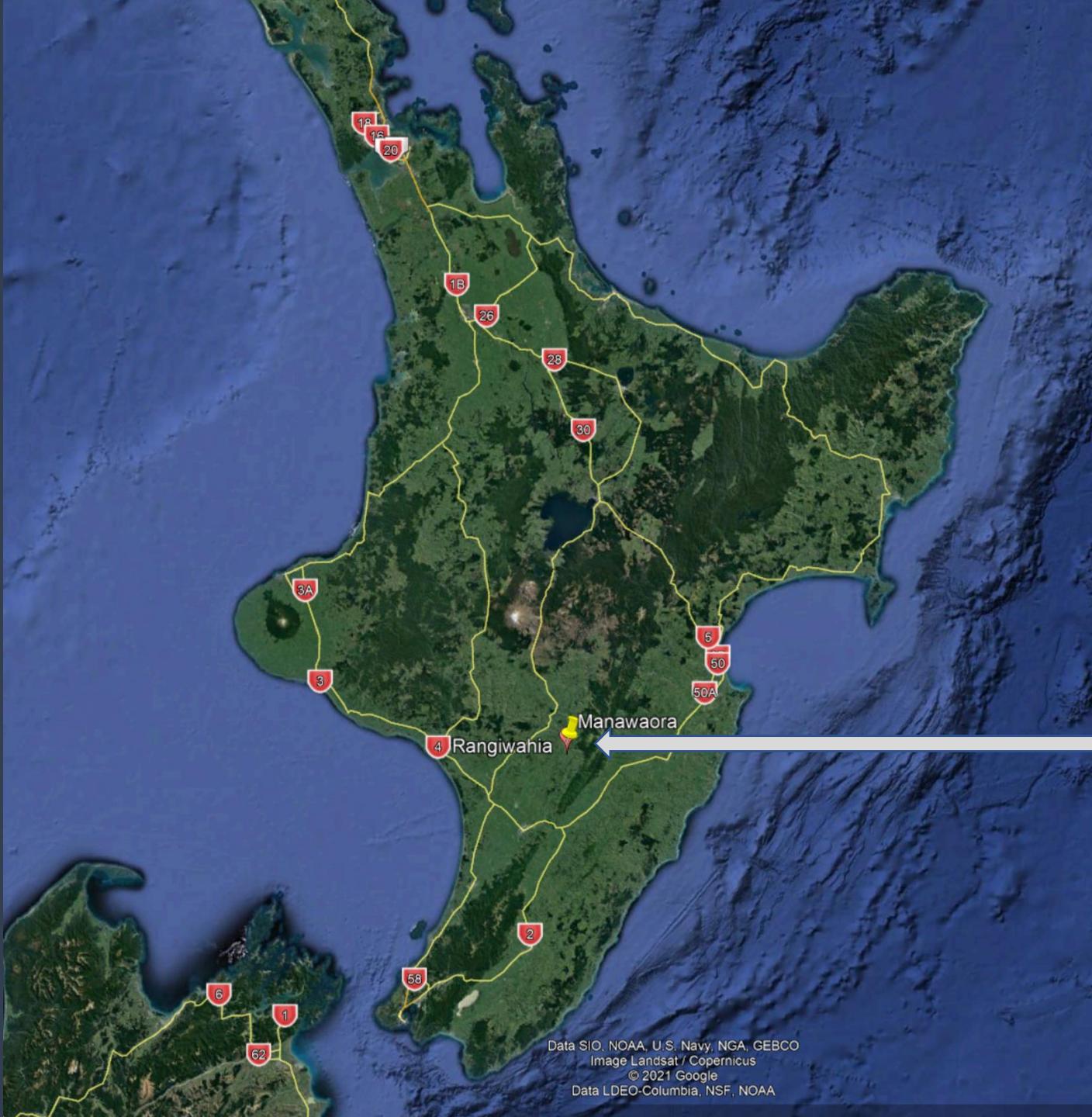
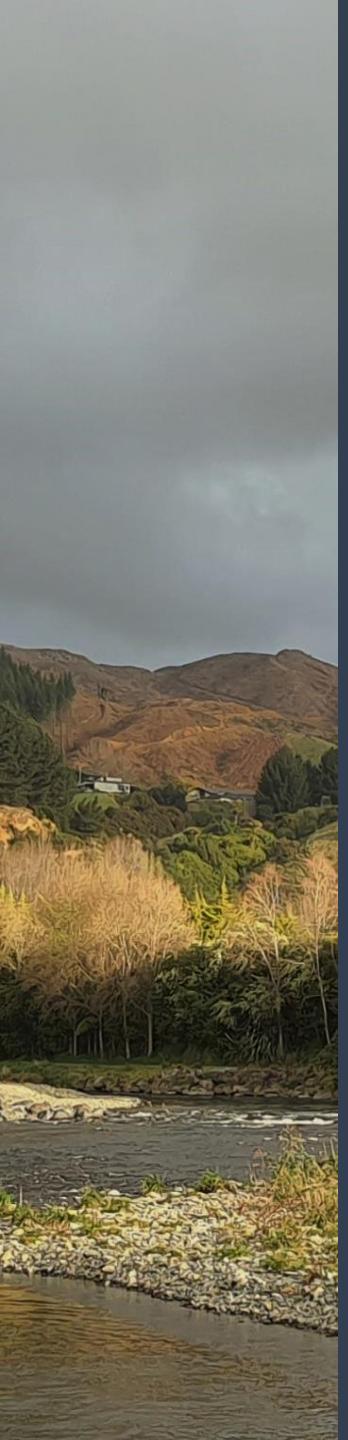
Could structure-from-motion help us?



Greater Wellington Lidar Survey

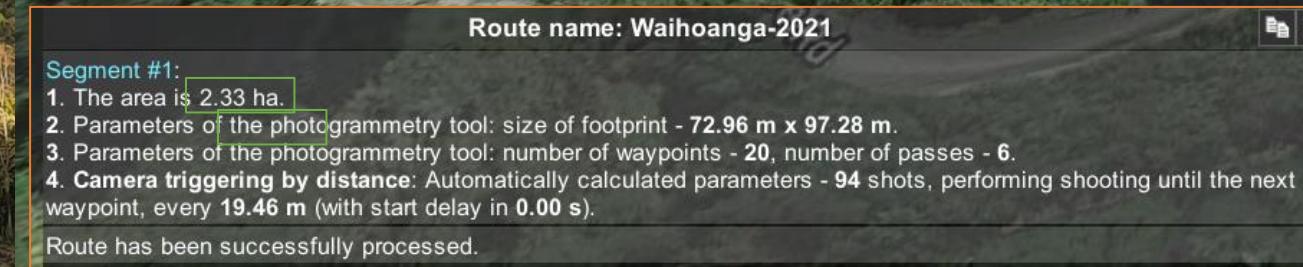
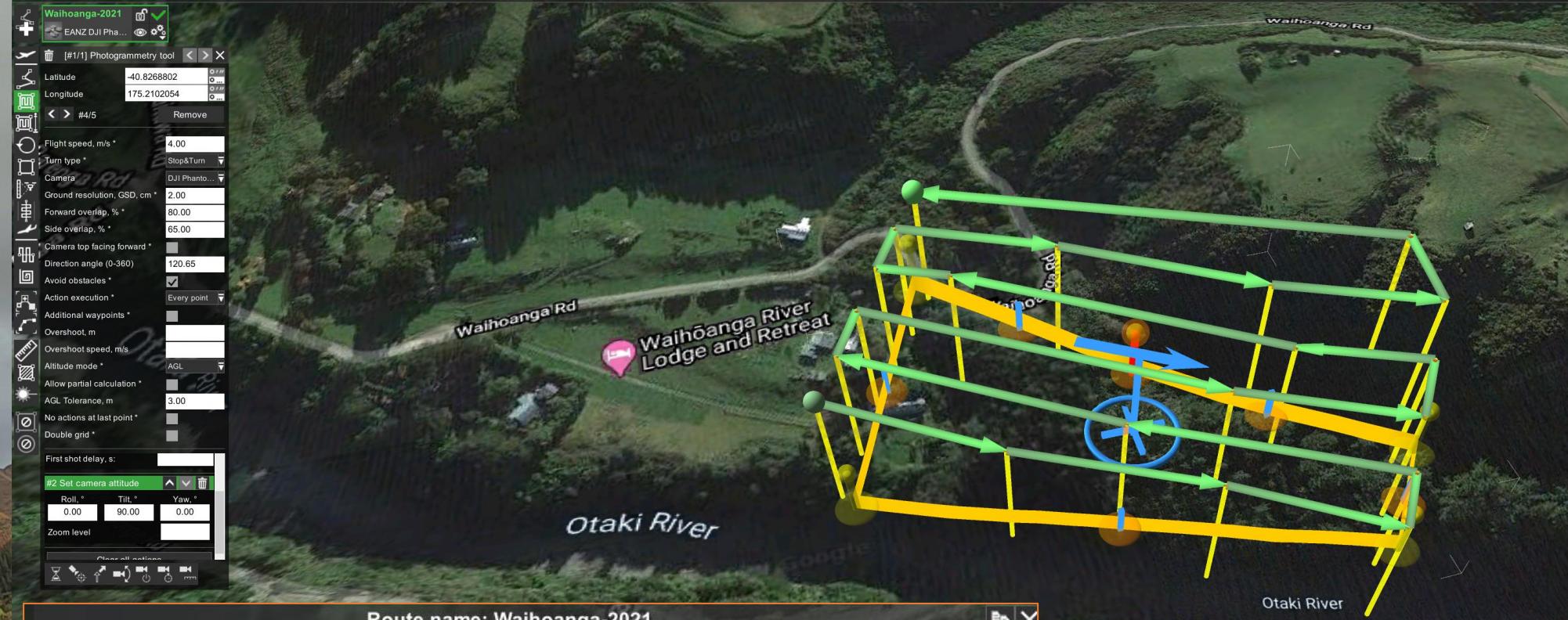


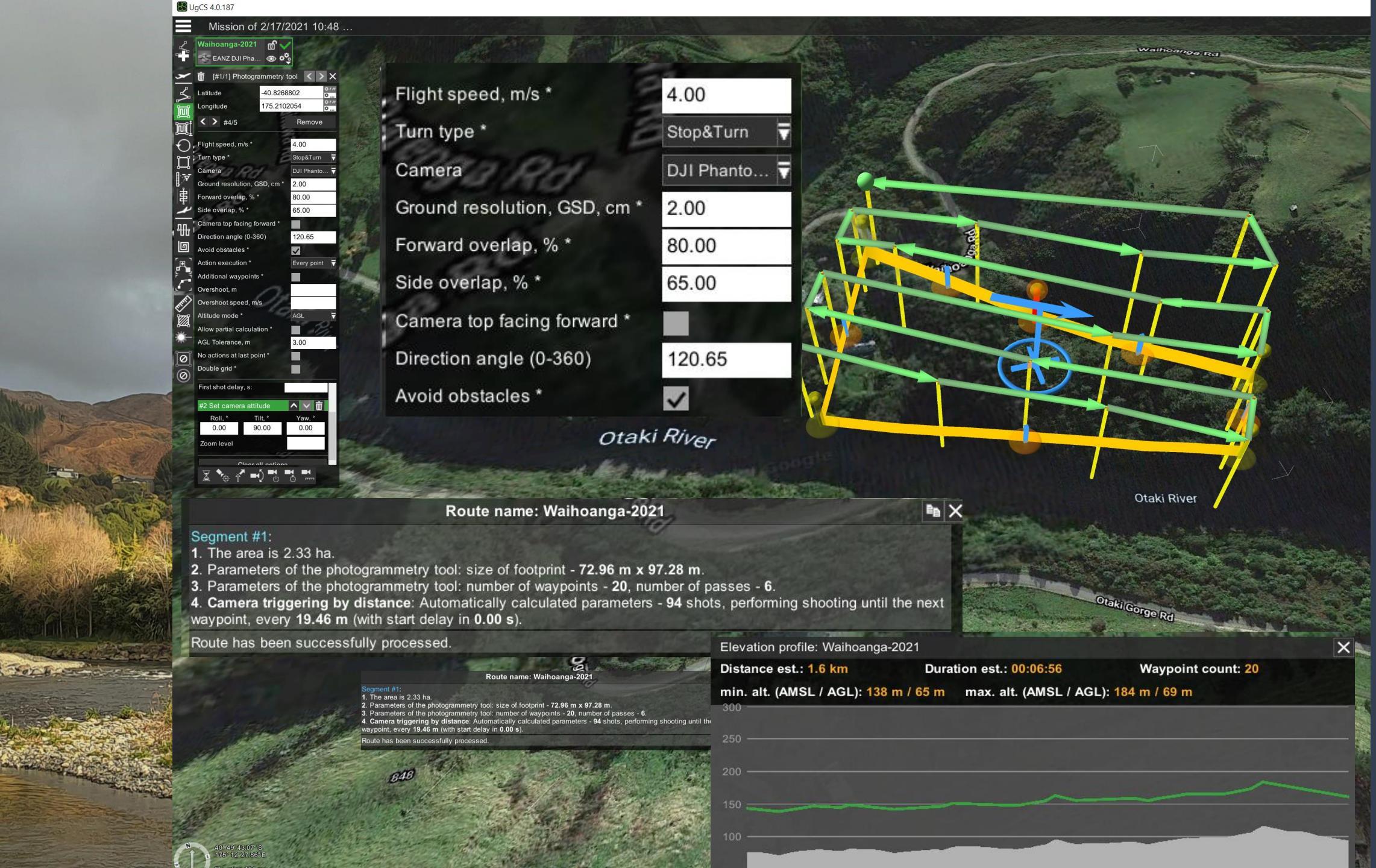
Today Drone Survey





Mission of 2/17/2021 10:48 ...







RPAS Exercise and report

(Write 1-5 paragraphs as required for each question)

1. *Describe the Advantages and Disadvantages of UAV's as remote sensing tool (20 %)*
2. *Describe three different sensors and what they are used for (20%)*
3. *Describe basic principle of SfM and the steps required to start a survey (20%)*
4. *Compare methods for generating digital terrain models and digital surface models (20%)*
5. *Describe approach to determine what trees have been removed from the Waihōanga stand since 2013 (20%)*