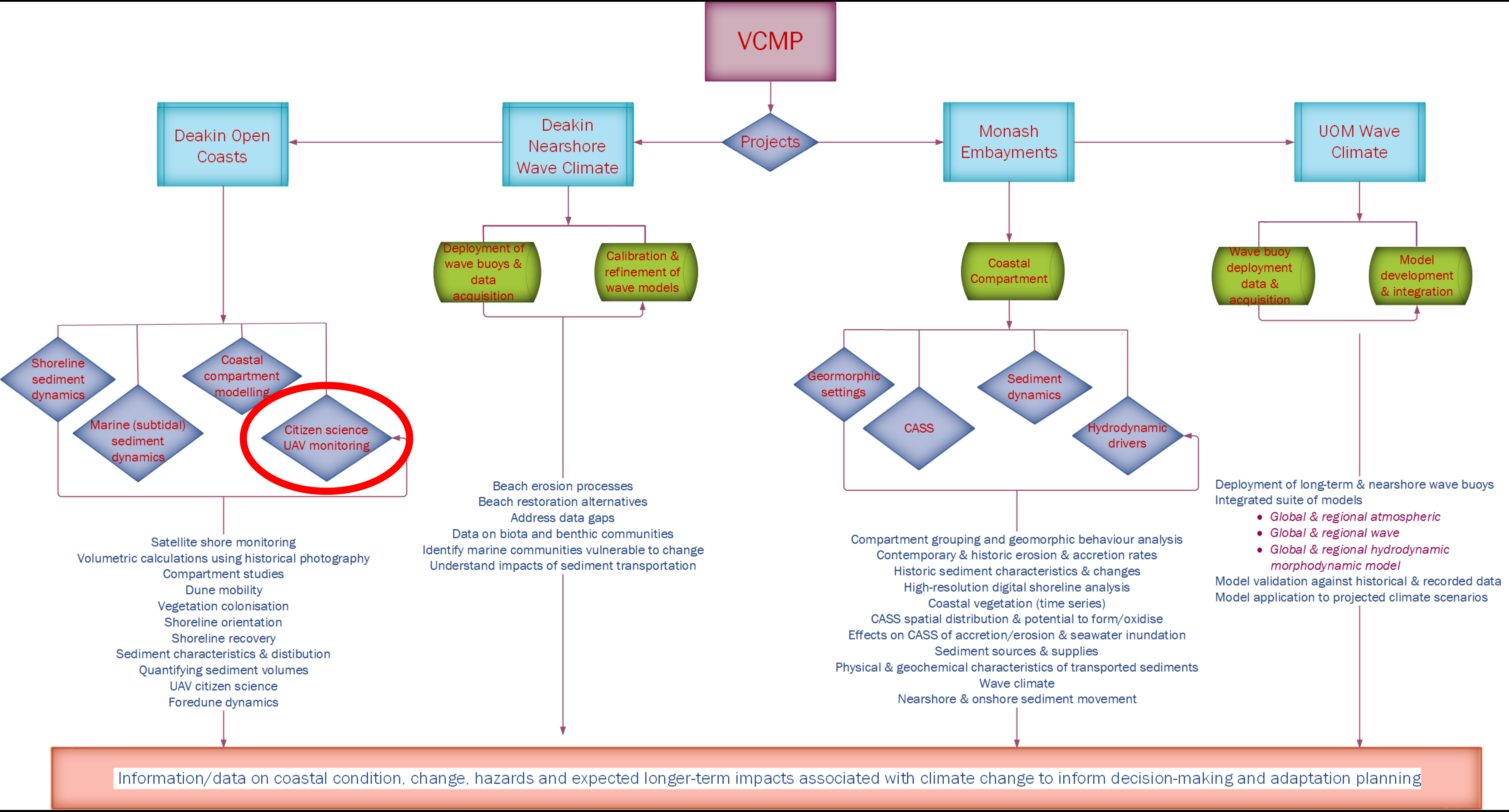
# Victorian Coastal Monitoring Program

**Blake Allan**[1], Daniel Ierodiaconou[1], David Kennedy[2], Nicolas Pucino[1], Rafael Carvalho[1], Karina Sorrell[2], Mary Young[1]

**Deakin University**[1]
**University of Melbourne**[2]

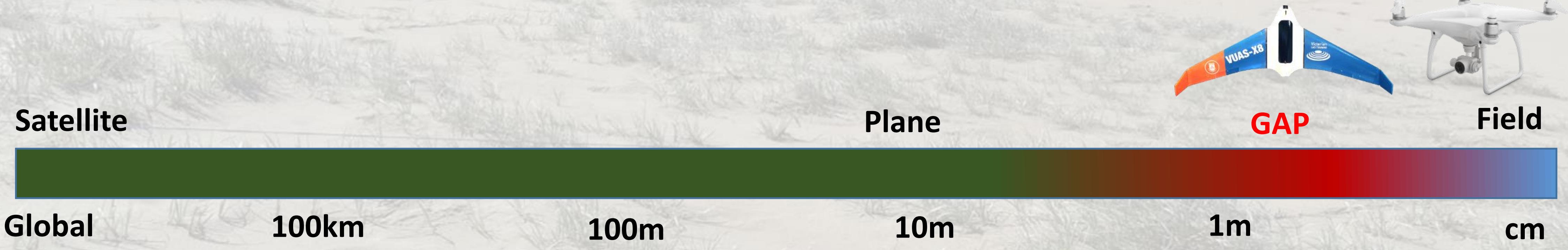

VCMP
Projects
Deakin Open Coasts
Deakin Nearshore Wave Climate
Monash Embayments
UOM Wave Climate
Deployment of wave buoys & data acquisition
Calibration & refinement of wave models
Coastal Compartment
Wave buoy deployment data & acquisition
Model development & integration
Shoreline sediment dynamics
Marine (subtidal) sediment dynamics
Coastal compartment modelling
Citizen science UAV monitoring
Geormorphic settings
CASS
Sediment dynamics
Hydrodynamic drivers
Satellite shore monitoring
Volumetric calculations using historical photography
Compartment studies
Dune mobility
Vegetation colonisation
Shoreline orientation
Shoreline recovery
Sediment characteristics & distibution
Quantifying sediment volumes
UAV citizen science
Foredune dynamics
Beach erosion processes
Beach restoration alternatives
Address data gaps
Data on biota and benthic communities
Identify marine communities vulnerable to change
Understand impacts of sediment transportation
Compartment grouping and geomorphic behaviour analysis
Contemporary & historic erosion & accretion rates
Historic sediment characteristics & changes
High-resolution digital shoreline analysis
Coastal vegetation (time series)
CASS spatial distribution & potential to form/oxidise
Effects on CASS of accretion/erosion & seawater inundation
Sediment sources & supplies
Physical & geochemical characteristics of transported sediments
Wave climate
Nearshore & onshore sediment movement
Deployment of long-term & nearshore wave buoys
Integrated suite of models
Global & regional atmospheric
Global & regional wave
Global & regional hydrodynamic morphodynamic model
Model validation against historical & recorded data
Model application to projected climate scenarios
Information/data on coastal condition, change, hazards and expected longer-term impacts associated with climate change to inform decision-making and adaptation planning

# Overview

- What is the Citizen Science UAV Monitoring?
- What is being collected?
- Progress to date
- The challenges of Citizen Science UAV Coastal Monitoring

# Citizen Science Monitoring

- Monitoring priority foreshore areas
- Changes in the volume, topography and extent of beach sands and foreshore morphology



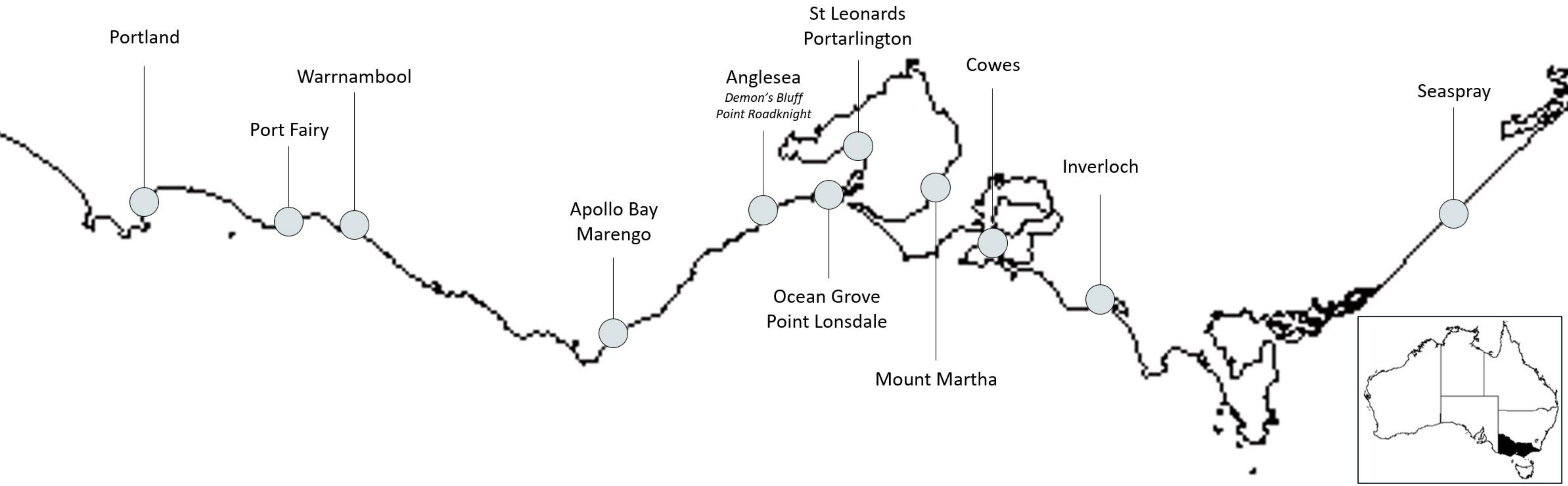

- UAVs: Bridge gap between traditional remote sensing  and field observations

# Citizen Science Monitoring

- Collection of survey-grade data
  - Horizontal accuracy < 5 cm
  - Vertical accuracy < 10 cm
- Collection approximately every 6 weeks
- Using small (< 2 kg) UAVs
- Data available to everyone online

propeller

# Priority Locations



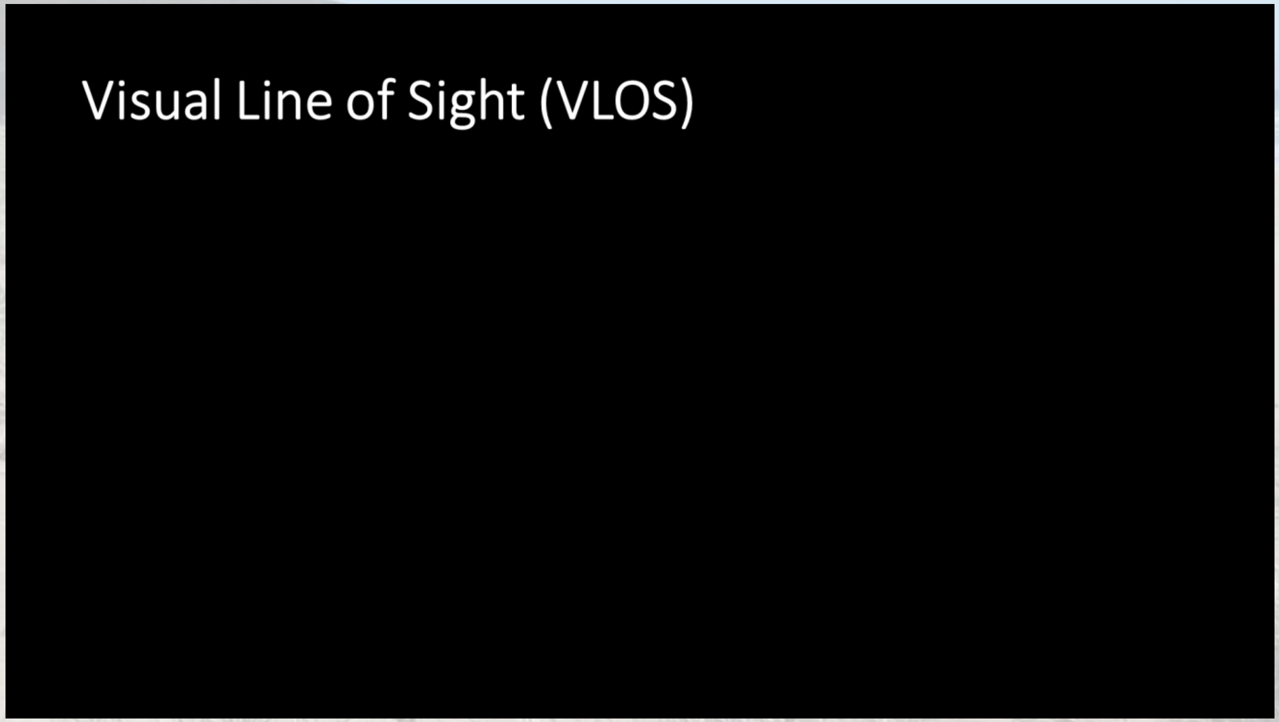

- 15 Locations along the Victorian coastline

# Equipment

- Phantom 4 Pro
- 3 Batteries
- iPad Mini
- AeroPoints
- Safety Equipment


# Training

- Theory Training – Regulations pertaining to < 2 kg Operation
  - 30 m from people and property
  - Not near registered aerodromes
  - Line of sight
  - During daylight hours
  - Separation from manned aircraft
  - Below 400 feet (121 m)
  - VMC conditions (weather)



# Training

- Practical Training
  - UAV safety, handling, transport, and storage
  - Assembly/Disassembly
  - Flight controls and flight modes
  - Airframe inspections
  - Flight manoeuvres
  - Emergency procedures
  - Automated mission planning – data collection
  - Camera operation
  - High-precision GPS use

# Training Manuals

Victorian Coastal Monitoring Program

Citizen Science Coastal Monitoring

Standard Survey & Operational Procedures for UAV Mapping Coastal Erosion

Victorian Coastal Monitoring Program

Citizen Science Coastal Monitoring

Practical Training Syllabus

# What Is Being Collected?

# Data Collection

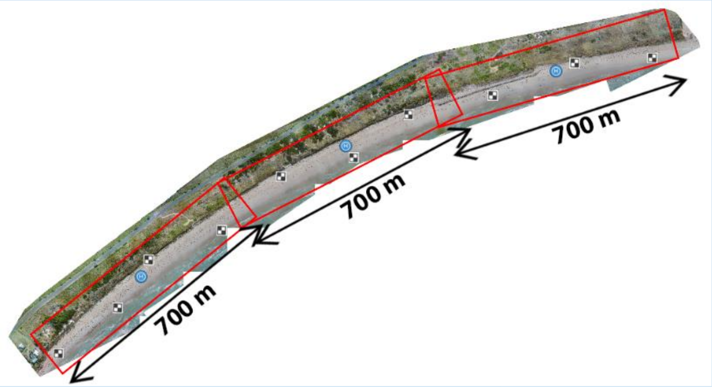
- 3 flights covering ~ 2 km

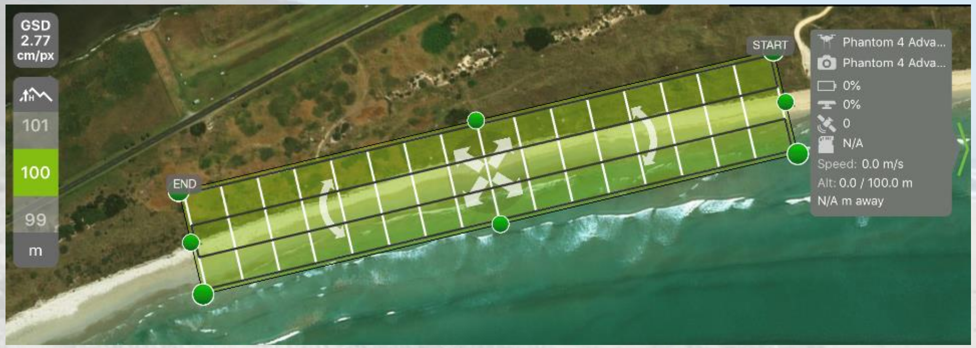
- Crosshatch flight pattern

- Approximately 600 20 MP images
  - < 3 cm/pixel on the ground

- 10 Ground Control Points

- Upload data for processing



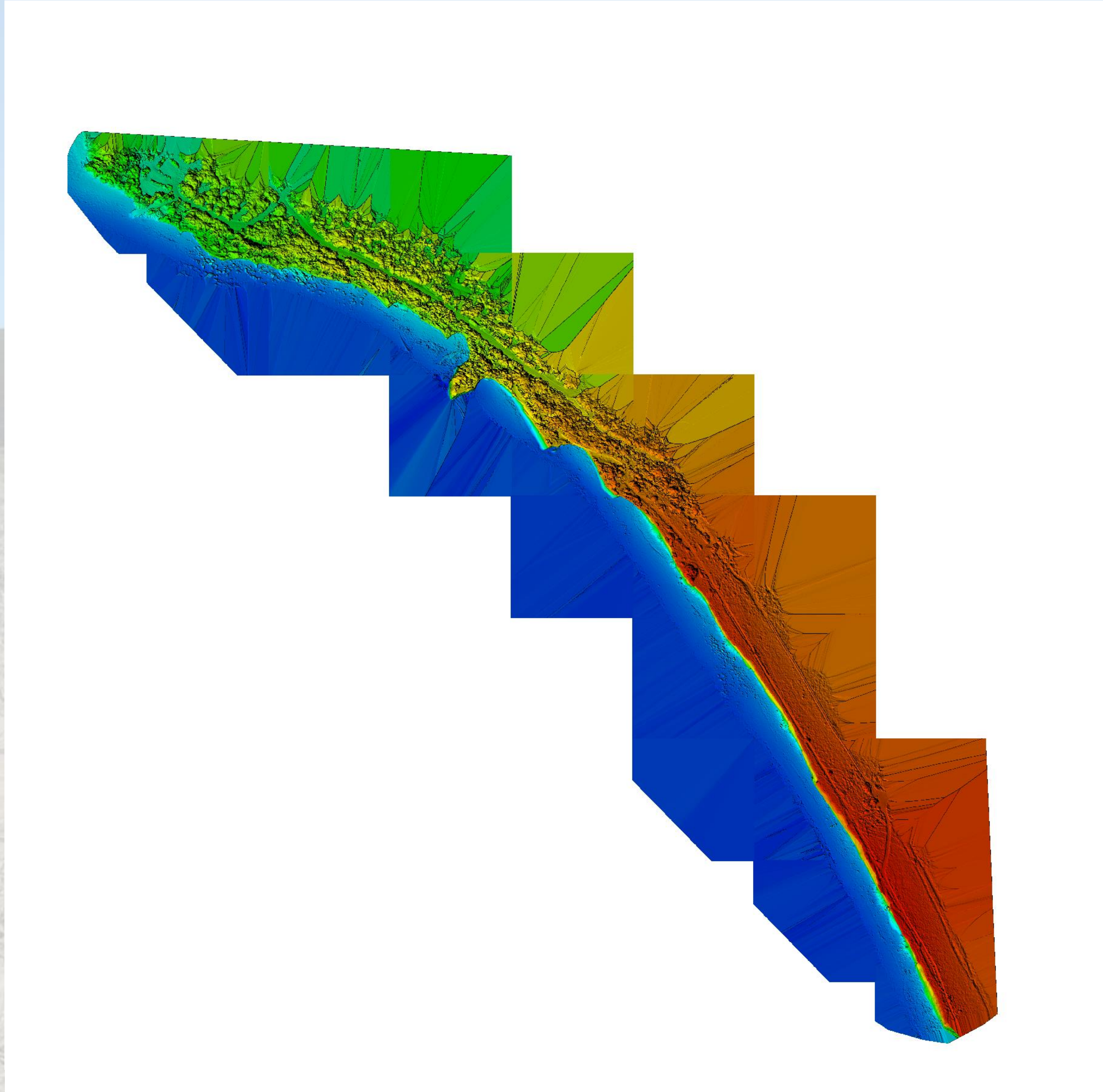

# Data Processing

- Local data processing in Pix4D photogrammetry software
- Quality Assurance (QA) against independent fixed points and landmarks
- Upload to PropellerAero Online Portal

https://www.marinemapping.org/vcmp-citizen-science

# UAV Data

- Orthomosaics
  - RGB GeoTIFF (~3 cm/pixel)
  - DSM (~3 cm/pixel)
  - DTM (~15 cm/pixel)



# UAV Data

- Orthomosaics
  - RGB GeoTIFF (~3 cm/pixel)
  - DSM (~3 cm/pixel)
  - DTM (~15 cm/pixel)

- Point Clouds

# UAV Data

- Orthomosaics
  - RGB GeoTIFF (~3 cm/pixel)
  - DSM (~3 cm/pixel)
  - DTM (~15 cm/pixel)

- Point Clouds

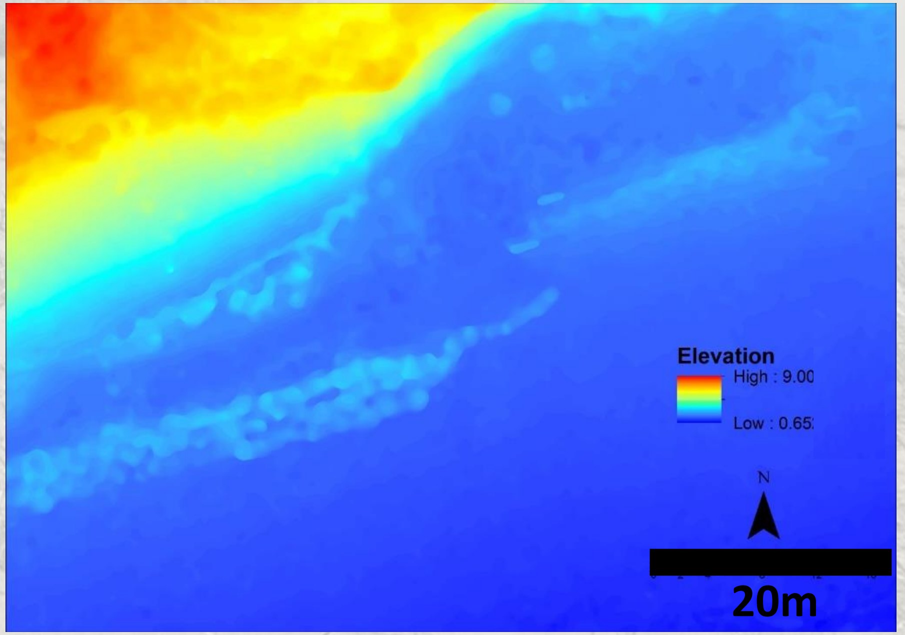
- Triangular Mesh

# Citizen UAV Data Applications

- Providing baseline and time series  data for coastal areas

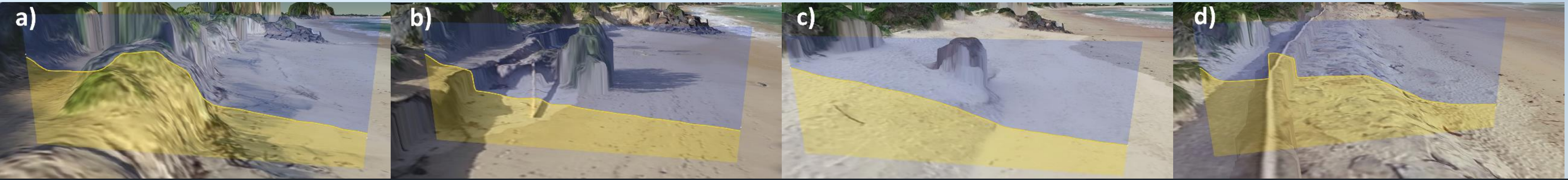
- Monitoring physical change
  - Measure erosion and accretion
  - Beach and cliff stability

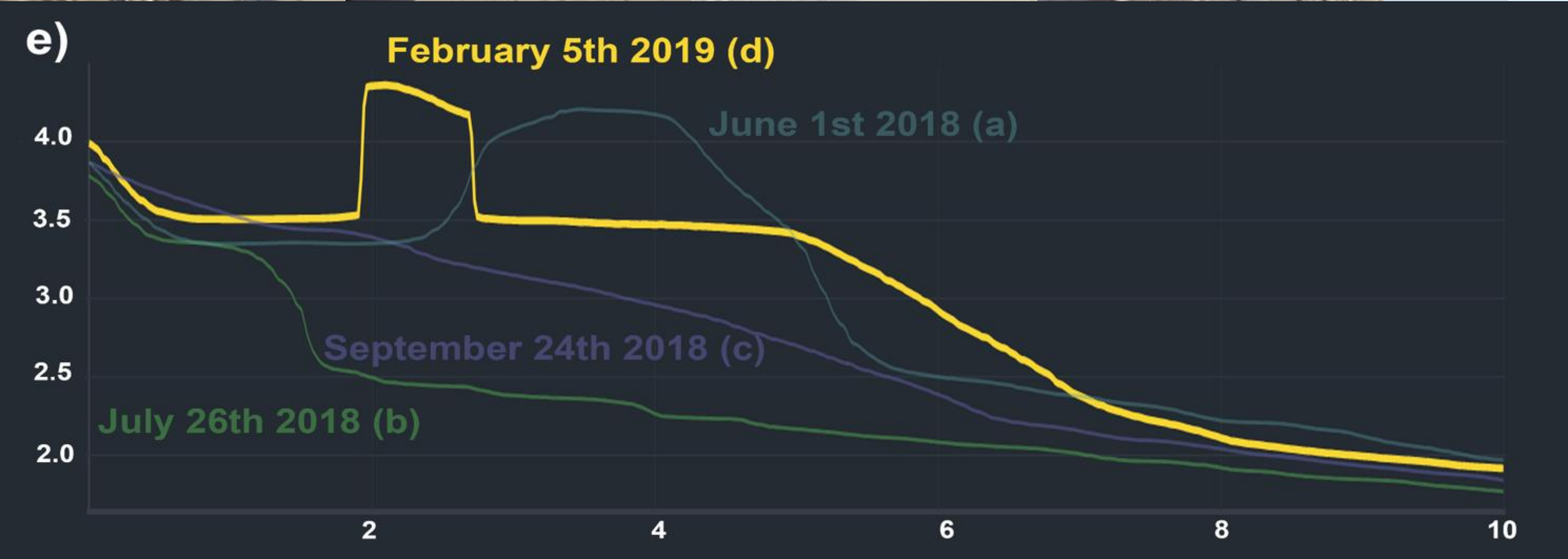
- Assessing biological habitats
  - Saltmarsh, mangroves
  - Intertidal reefs

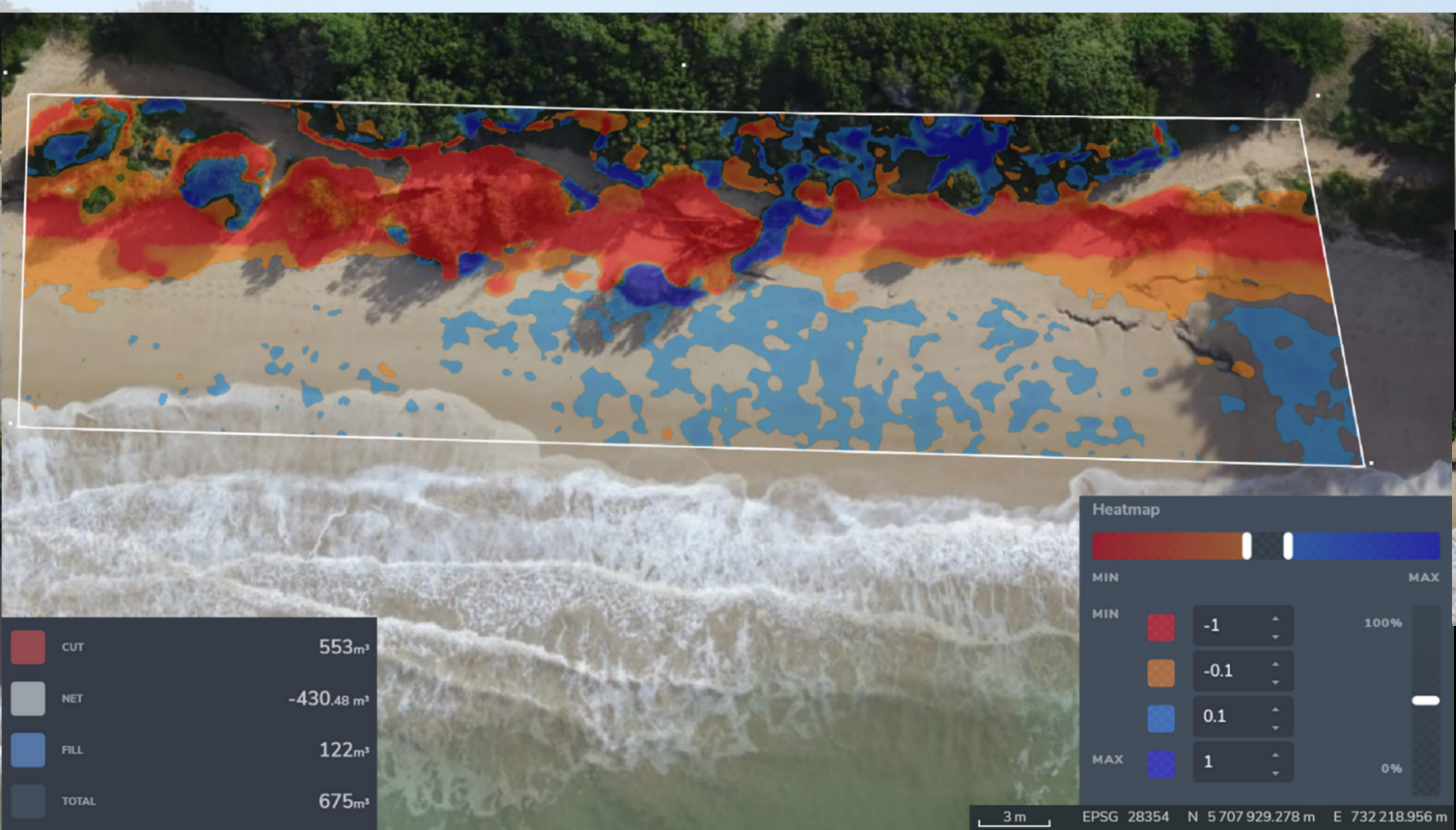
# Propeller Aero - Elevation History

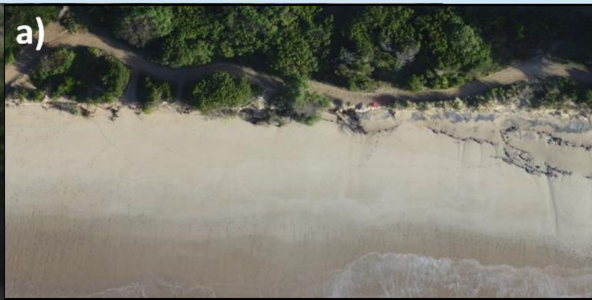
# Propeller Aero - Cross-Sections



# Propeller Aero - Volumetrics

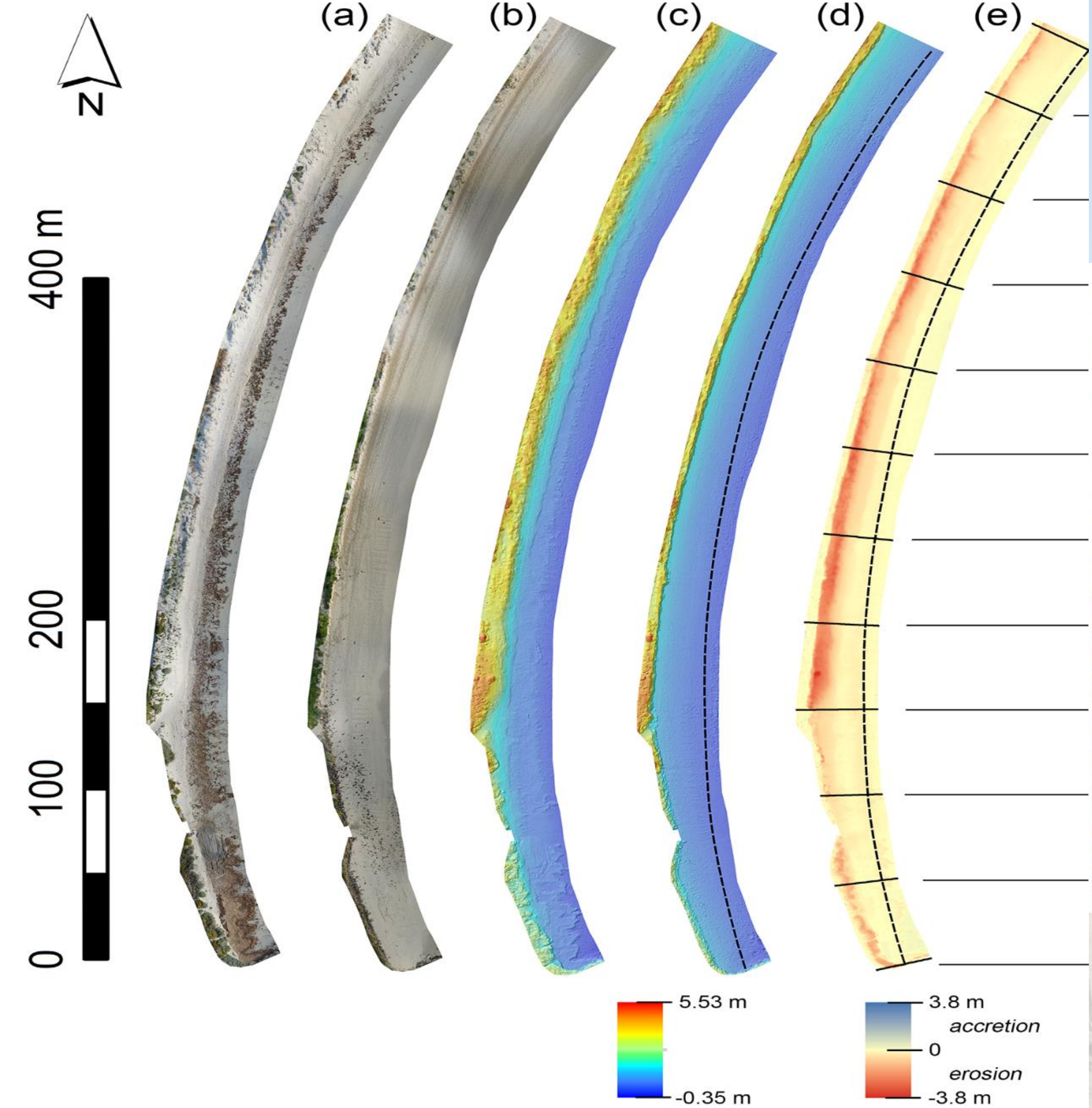


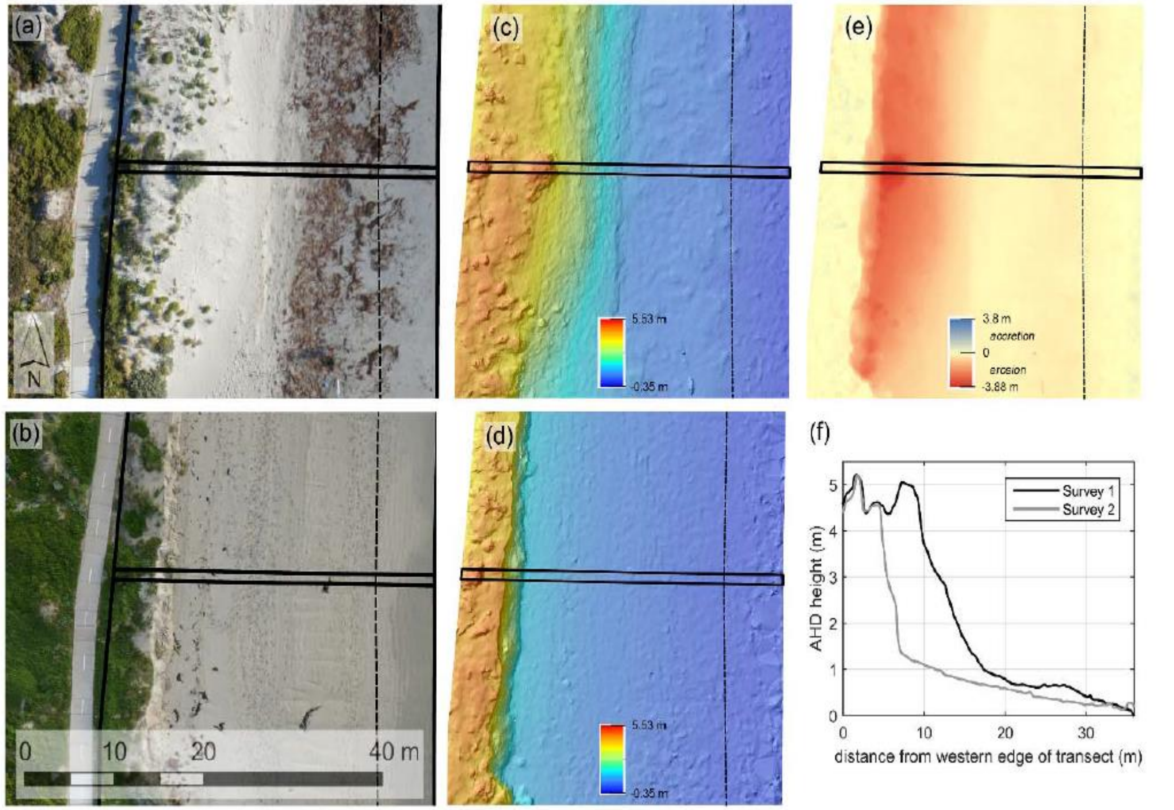




June 1st 2018


July 26th 2018

# Warrnambool Harbour Before and After an Major Storm Event

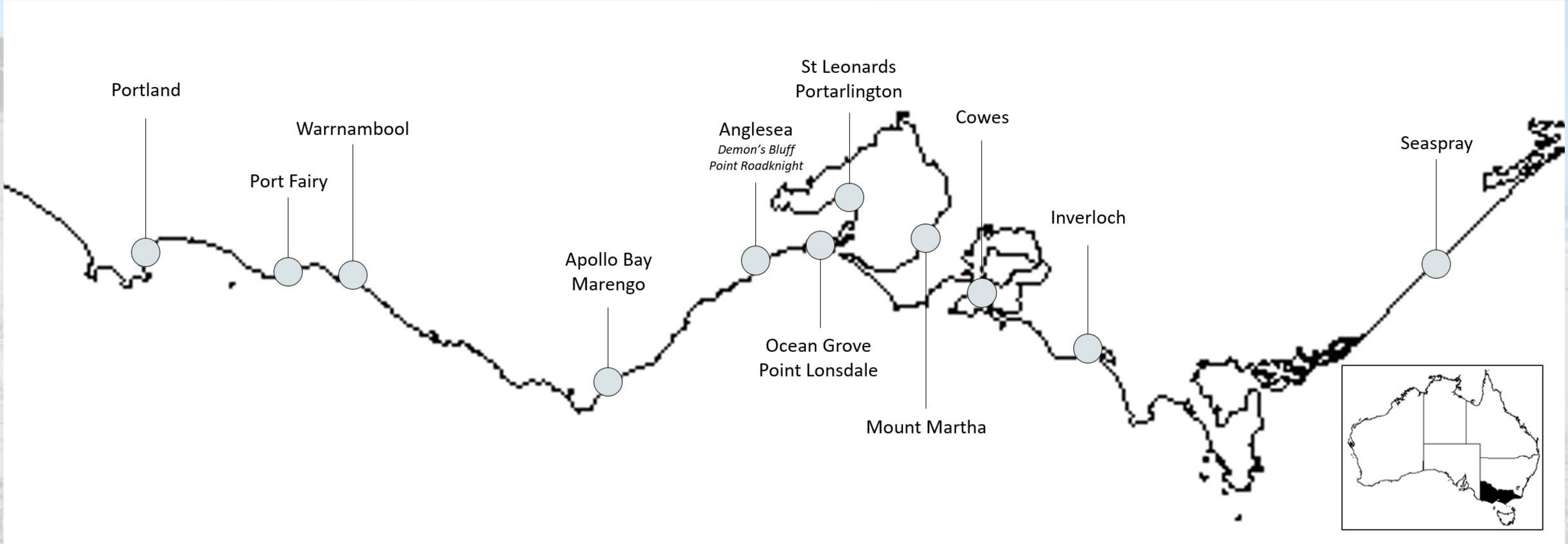



**Ierodiaconou , Kennedy, et al. , Zeit. fur Geomorphologie 2016**

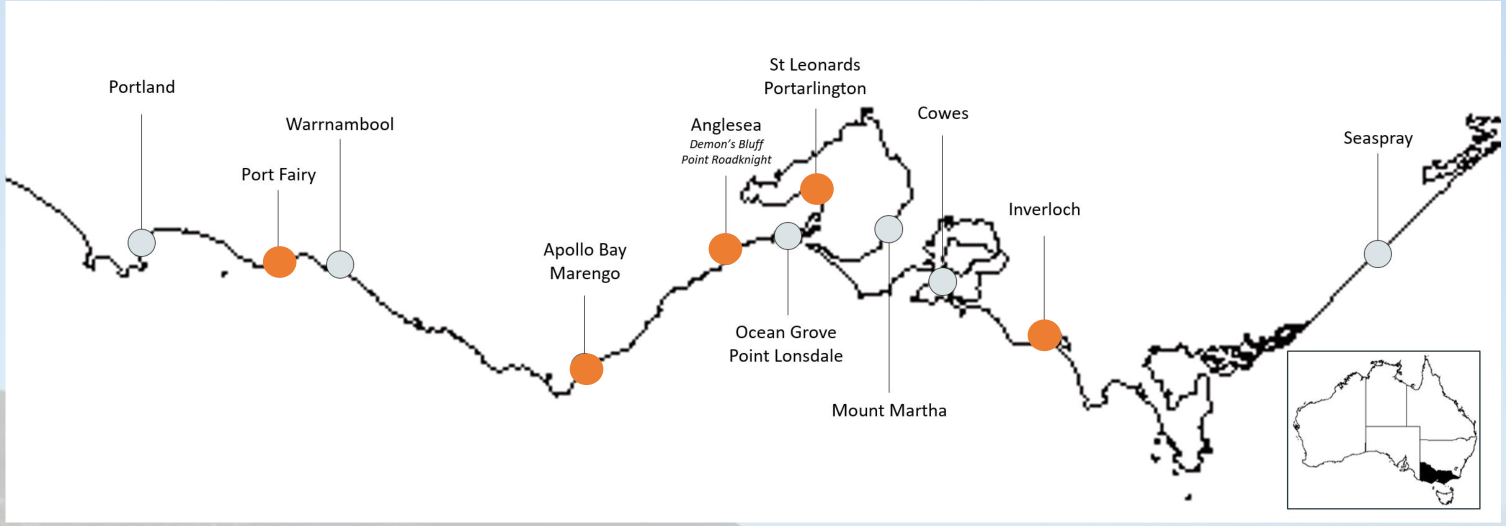
# Progress to Date

# Progress to Date




**Portland (2)**
**Port Fairy (11)**
**Warrnambool (10)**
**Marengo (9)**
**Apollo Bay (9)**
**Anglesea Demon's Bluff (8)**
**Anglesea Point Roadknight (8)**
**Ocean Grove (2)**
**Point Lonsdale (3)**
**St Leonards (7)**
**Portarlington (7)**
**Mount Martha (1)**
**Cowes (7)**
**Inverloch (6)**
**Seaspray (5)**

# Progress to Date

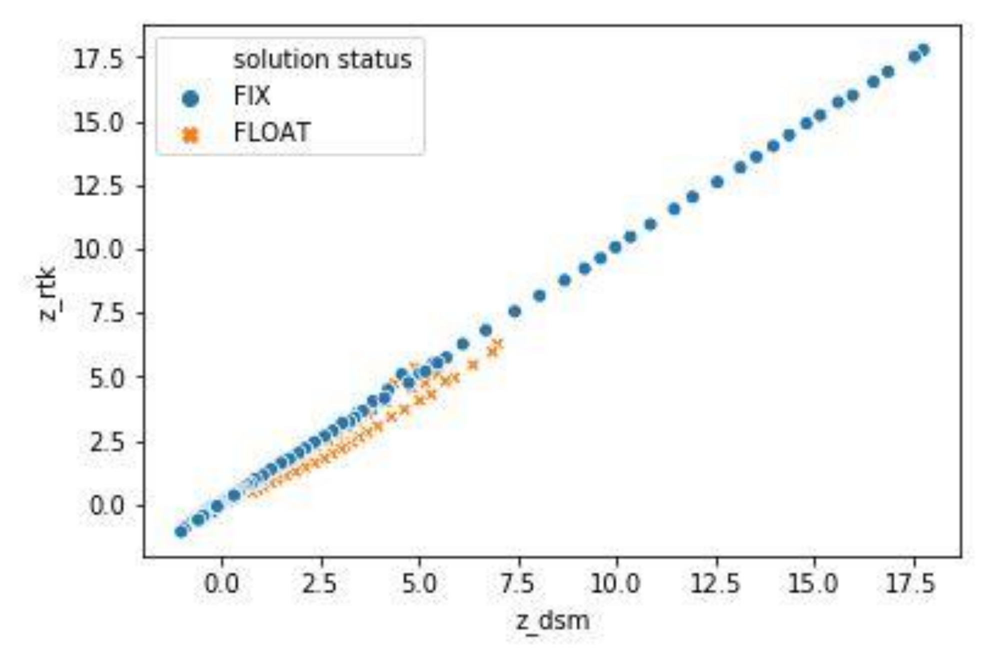



- 95 datasets collected
- 8 sites operating independently
- Commencing Science Team Surveys
  - Larger areas (> 10 km) in key areas, expanding on the Citizen Science flights
  - Encompassing entire beach crescents
  - Every 3-6 months

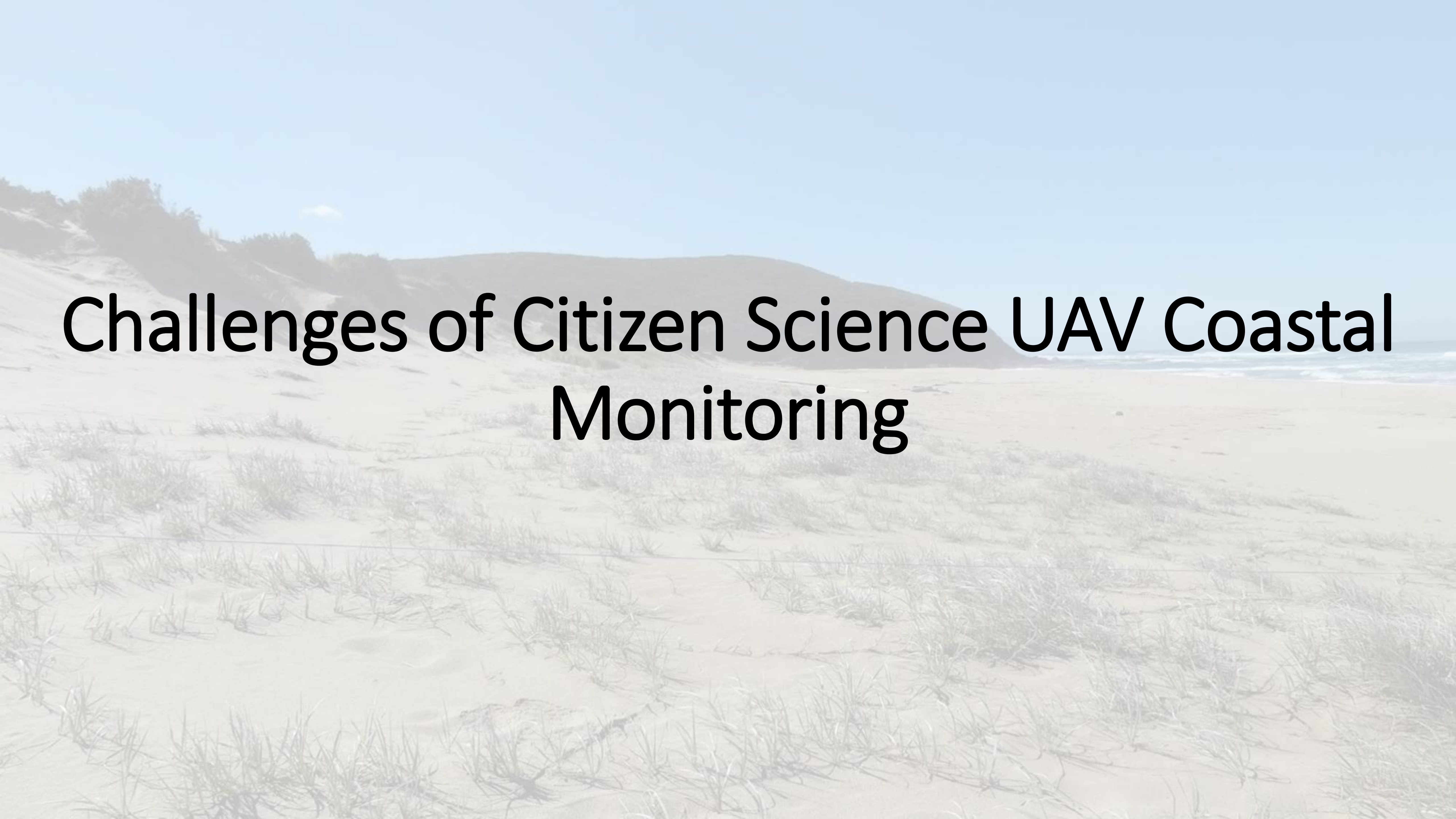
# Quality Assurance

| | fid | x | y | z_dsm | lateral rms | tr_id | z_rtk | new_field | z_diff |
|---|---|---|---|---|---|---|---|---|---|
| count | 150.000000 | 150.000000 | 1.500000e+02 | 150.000000 | 150.000000 | 150.000000 | 150.000000 | 150.000000 | 150.000000 |
| mean | 109.673333 | 630516.725701 | 5.748889e+06 | 2.893818 | 0.004704 | 3.613333 | 2.937904 | 107.233333 | -0.044086 |
| std | 68.745567 | 1139.485686 | 3.414026e+02 | 4.739371 | 0.001037 | 2.382224 | 4.750810 | 67.005300 | 0.077730 |
| min | 1.000000 | 628838.900500 | 5.748539e+06 | -1.013198 | 0.002600 | 0.000000 | -1.075440 | 1.000000 | -0.514993 |
| 25% | 39.250000 | 629083.574250 | 5.748563e+06 | -0.138148 | 0.003925 | 1.000000 | -0.095515 | 39.250000 | -0.081568 |
| 50% | 133.500000 | 631189.392150 | 5.748789e+06 | 0.770039 | 0.004700 | 5.000000 | 0.790380 | 129.500000 | -0.047882 |
| 75% | 170.750000 | 631634.218100 | 5.749270e+06 | 3.828357 | 0.005400 | 6.000000 | 3.946635 | 166.750000 | -0.023891 |
| max | 208.000000 | 631679.697000 | 5.749501e+06 | 17.777303 | 0.008000 | 6.000000 | 17.797445 | 204.000000 | 0.141925 |

- Mean Error (ME) = 4cm
- DSM values are slightly overestimated, but accurate.
- Vertical (z) Root Mean Squared Error (RMSE) = 9cm
  - Commensurate to the scientific UAV literature and aerial LiDAR surveys.



# Challenges of Citizen Science UAV Coastal Monitoring



# Challenges

1) Parks Victoria land
   - Citizen Science groups cannot operate in Parks Victoria land

2) Data processing
   - Vertical data error at land/sea interface requiring manual cleaning
   - Quality Assurance

3) Insurance
   - Over 6 months to organise UAV insurance for volunteers

4) Cost
   - Approximately $55,000 - $60,000 per group for 3 years

Within **3 years** Citizen Scientists will have produced >**300 datasets** …

… **15 locations** with differences in wind, wave and sediment regimes. **Good research** possibilities!

… there will be **1-2 Tb of DSM and orthomosaics** to analyse …

## How to analyse such an amount of geospatial data in an efficient way?

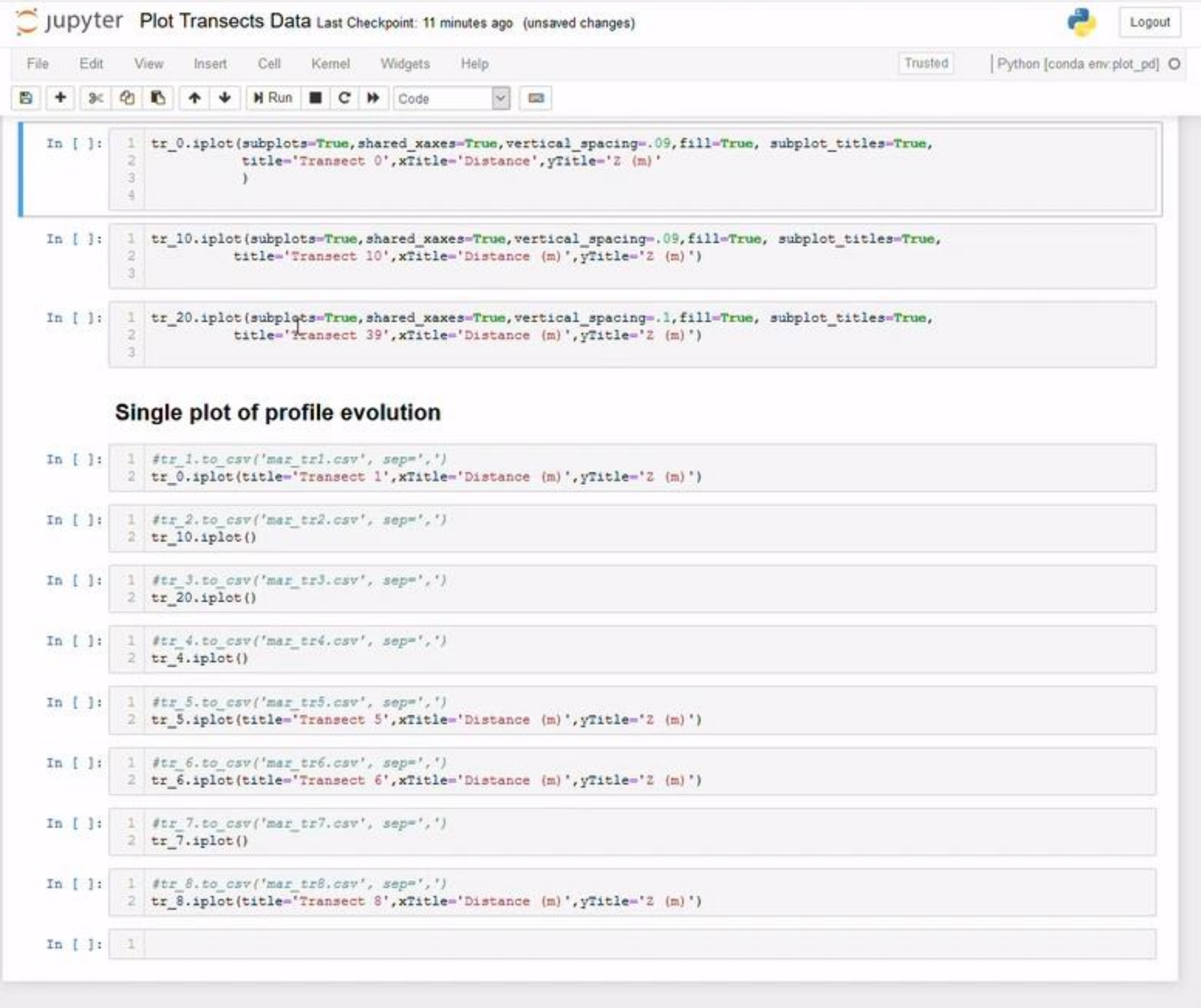
pgAdmin 4

**PostgreSQL + PostGIS**

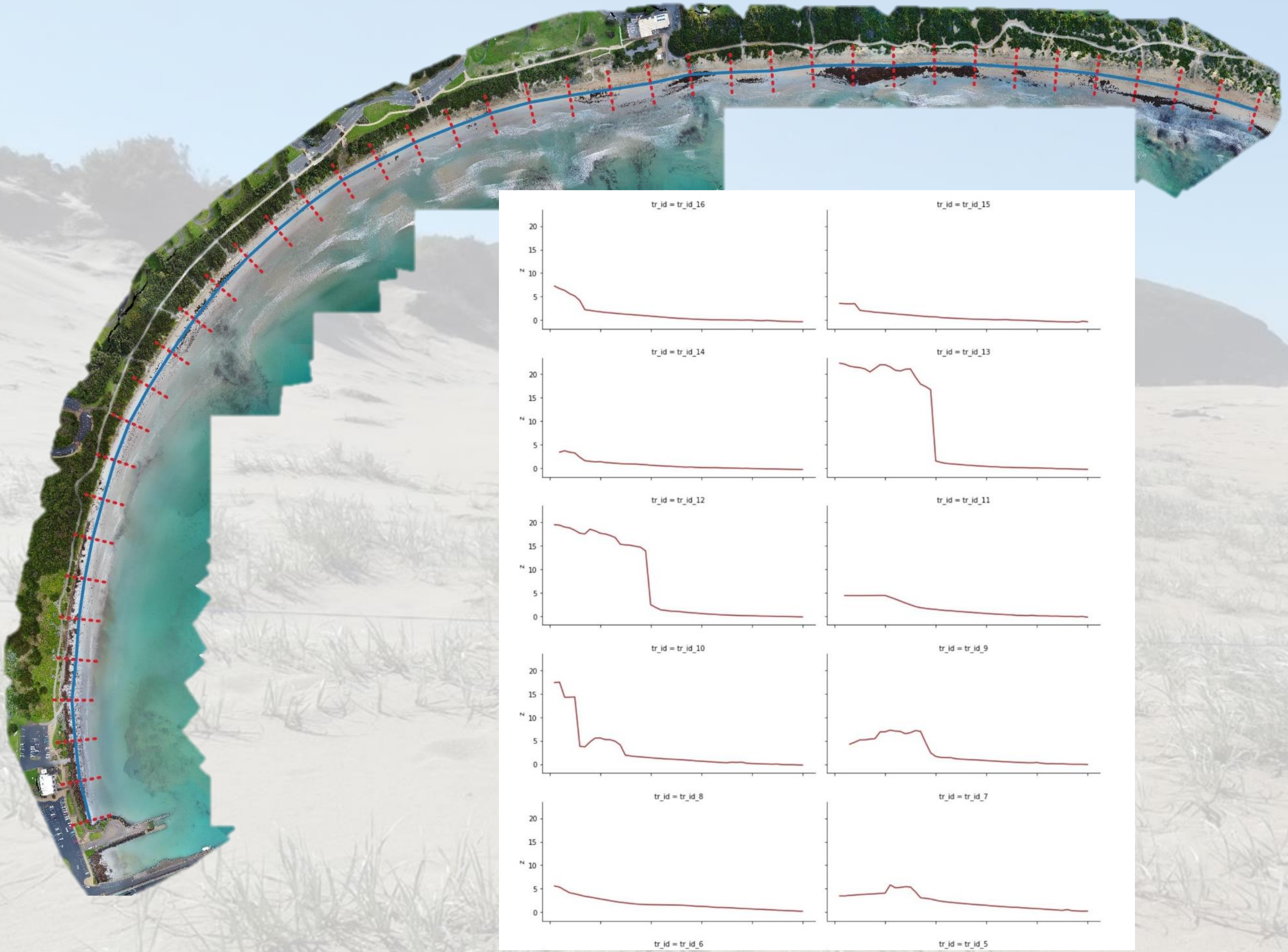
+

jupyter

**Python Geospatial Scripting**




- **Automatic** extraction of all elevation profiles along the multitemporal DSMs
- **2 main inputs**: the DSMs and the transects (vector lines)
- **1 big data table**, text format, full of information
- **Python** geospatial processing is fast and efficient
- **Interactive plotting** inside Jupyter Notebooks
- **Powerful** geostatistical analysis with Geopandas
- **Big Data** table feeds directly into PosgreSQL to be manipulated and queried with PostGIS
- Fits with **Qgis** and **ArcGIS**


tr_id = tr_id_16
tr_id = tr_id_15
tr_id = tr_id_14
tr_id = tr_id_13
tr_id = tr_id_12
tr_id = tr_id_11
tr_id = tr_id_10
tr_id = tr_id_9
tr_id = tr_id_8
tr_id = tr_id_7
tr_id = tr_id_6
tr_id = tr_id_5
z
0
5
10
15
20