Exploring the use of UAVs for Coastal Research Purposes

Authors: Joshua Bilkey[1], Dr Hannah Buckley[1], Dr Bradley Case[1] and Graham Hinchliffe[1]

School of Science, Auckland University of Technology Correspondence: Bradley.Case@aut.ac.nz or Josh.Bilkey@aut.ac.nz

Why Unmanned Aerial Vehicles (UAVs)?

- Higher resolution (centimetre scale) than satellite imagery allowing for (semi)-automated identification of plants down to species level.
- More efficient than field collection in addition to reducing trampling and potential cross-contamination effects associated with fieldwork. Can be used to supplement or in some cases replace field surveys.
- Rapid deployment – therefore can be used to track temporal changes (for weeds or threatened species etc.) over multiple missions easily.
- UAVs can reach remote/hard to access areas . Therefore, allowing additional data to be generated.
- UAVs can create both a 2-D and 3-D model from a single flight mission. Allowing both vegetation classification of a 2-D image and volumetric analysis of the dune structure. This is particularly useful in tracking any morphological changes to the foredune structure and how this influences vegetation composition.

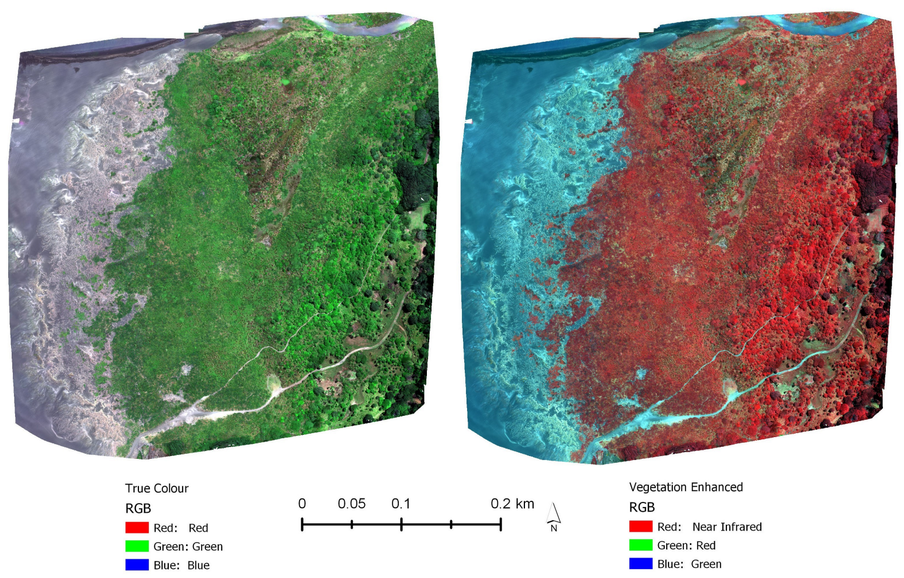

Figure 1: 5cm resolution orthomosaics of Karekare Beach created from a series of six UAV flights completed on November 7th 2018. Left Image: True Colour image where red, green and blue channels are also the red, green bands of the sensor. Right Image: Vegetation Enhanced image where bright red colours represent plants with high Near infrared reflectance (an analogue of the amount of chlorophyll produced).

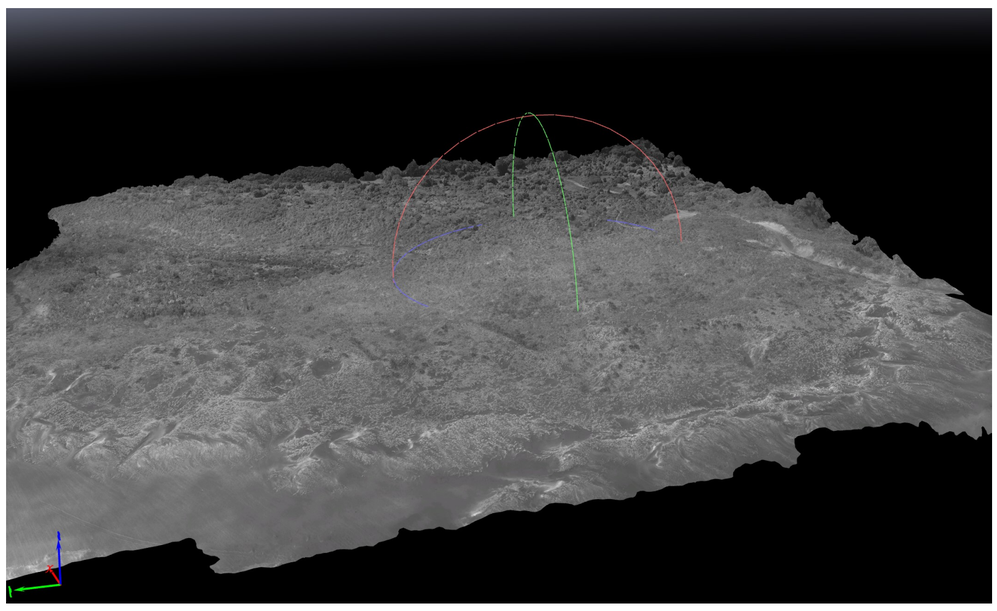

Figure 2: 5cm 3-D Digital Surface Model of Karekare beach produced from the same November 7th 2018 flight as Figure 1. Both 2-D and 3-D models produced by Pix 4-D digital mapping software.

Identifying coastal plant species using UAV imagery

UAVs are capable of producing centimetre-scale resolution. However, the enhanced resolution does not always equate to a better result. In many cases an individual scrub or plant can be incorrectly classified as multiple different species, the “salt-and-pepper” effect (Kelly et al., 2011). This is due to the various orientations and spectral qualities of individual leaves and branches (Kim et al., 2011) .

To counteract this, Object-Based Image analysis (OBIA) can be used to delineate groups of pixels with similar attributes i.e. shape, size, colour, texture pattern, shadow and association (Blundell and Opitz, 2008).

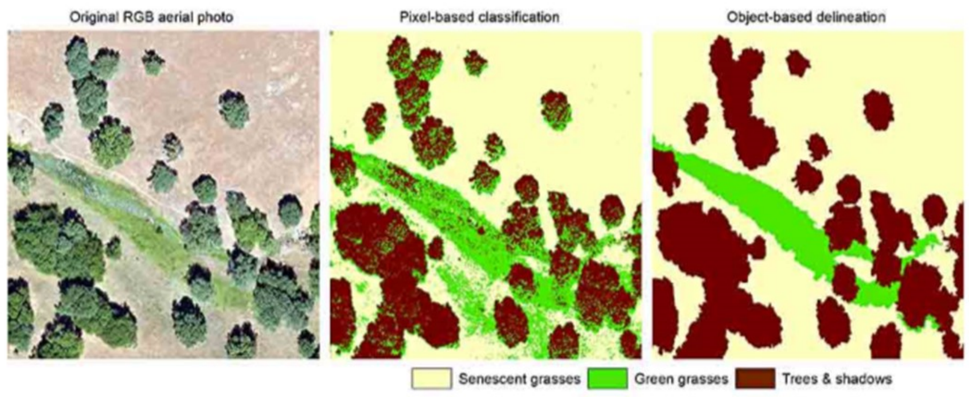

Figure 3: Example of object-based vs pixel based classification in an oak woodland. Source: https://frameworks.ced.berkeley.edu/2016/potential-remote-sensing-improve-landscape-research-monitoring-studied-spatial-scales/

Case Study of current sand dune research - Karekare Beach, Auckland - UAV Image Analysis

Aim: Develop and streamline processing techniques for using UAV data to identify vegetation composition of coastal environments.

Why Karekare beach?- high diversity of species common to many NZ coastal environments (Pingao, Muehlenbeckia complexa as well as exotics such as lupin and pampas). It also had a recent field survey completed by Auckland Council in late 2017 allowing for comparison.

Methods: UAV flights over study area collecting imagery with a resolution of 5cm. A RedEdge MicaSense sensor is attached to a Phantom 4 Pro UAV to create 2-D and 3-D models of the study site. Two missions spaced 4 months apart will be used to analyse temporal changes.

Object-Based Image Analysis (OBIA) is used for plant identification creating a map of vegetation composition.

Outputs: A data processing workflow for UAV-based dune monitoring and dune restoration projects.

Assessment of advantages and limitations of UAVs in comparison to both field surveys and aerial/satellite imagery analysis.

References

Kelly, M., Blanchard, S., Kersten, E. & Koy, K. (2011). Terrestrial Remotely Sensed Imagery in Support of Public Health: New Avenues of Research Using Object-Based Image Analysis*. Remote Sensing, 3,* 2321-2345.

Kim, S., Lee, W., Kwak, D., Biging, G. S., Gong, P., Lee, J. & Cho, H.-K. (2011.). Forest Cover Classification by Optimal Segmentation of High Resolution Satellite Imagery. *Sensors*, *11*(2), 1943–1958. https://doi-org.ezproxy.aut.ac.nz/10.3390/s110201943.

Opitz D. & Blundell S. (2008) Object recognition and image segmentation: the Feature Analyst® approach. In: Blaschke T., Lang S., Hay G.J. (eds) *Object-Based Image Analysis. Lecture Notes in Geoinformation and Cartography.* Springer, Berlin, Heidelberg.