IET International Travel Award Report

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The IET international travel award recently afforded me the opportunity to travel to French Polynesia to sail on the UN-sponsored Darwin200 voyage and map coral reefs with drones.

Darwin200 Overview

The Darwin200 (https://darwin200.com) is a 2-year long (2023-25) global circumnavigation voyage (2023-25) on the historic Dutch tallship Oosterschelde, starting in Tenerife, Spain, and finishing in Falmouth, UK. The purpose of the voyage is to re-trace Charles Darwin's voyage on the HMS Beagle, harnessing the legacy of his 200th anniversary to promote and conduct conservation-based scientific research in places he visited.

Project focus: Coral Reef Conservation

Global warming has led to increased ocean temperatures worldwide. When water temperatures exceed a certain threshold, it puts corals at risk of "bleaching". Bleaching is when corals expel the symbiotic algae (zooxanthellae) living in their tissue and turn white. While corals can survive bleaching, it places them under great biological stress and risk of mortality. When the corals do survive, it can take them up to a decade or more to fully recover from bleaching.

Currently, over half of the world's corals are exposed to bleaching-level temperatures, a number that is expected to increase to 100% before the end of the century. Given the fundamental importance of coral reefs to marine ecosystems, and the stress they have been put under by global warming, scientists are interested in low-cost, efficient practices for mapping and monitoring coral reef habitats. By doing so, we can further our understanding of their susceptibility to and trajectory of their recoveries from bleaching events and improve management practices.

Traditional vs. Drone Mapping Methods

Traditional methods of coral reef monitoring and mapping involve either satellite imagery or manual image collection via in-situ transects. Run-of-the-mill satellite imagery is limited by its spatial resolution, which is not suitable for identifying coral sub-structures. Higher resolution satellite imagery is prohibitively expensive. Manual data collection is also expensive, takes a long time to collect, and is limited to areas that can be accessed by boat.

Compared to traditional mapping methods, drones offer a relatively low-cost, quick, and high-resolution method of coral reef mapping. My mission in French Polynesia, along with my

research partner Timothy Lann (follow us @oxfordflyguys), was to use consumer-grade drone technology to gather high resolution aerial imagery data of coral reefs.

Fieldwork in French Polynesia

Our project started in Moorea, working with the locally-based CRIOBE lab (https://www.criobe.pf/en/home/) to identify target reef mapping sites. The sites we mapped are shown in Fig. 1.

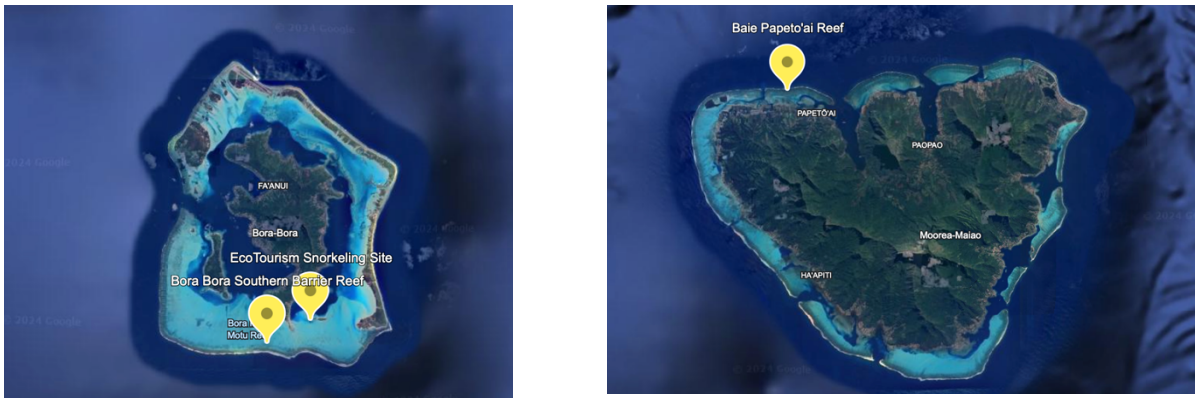

Figure 1: Target reef sites in Bora Bora (left) and Moorea (right). Images obtained from Google Earth.

The Bora Bora sites were chosen because researchers at CRIOBE are interested in comparing the recovery rate of corals at EcoTourism sites such as the Aquarium Snorkeling Site in Bora Bora, where humans snorkel among the corals, against sites with a lesser human physical presence such as the southern Barrier Reef. Data from the site in Moorea will be used in the process of developing convolutional neural network based-models to predict bleaching events.

Figure 2 shows some sample imagery from the Bora Bora Southern Barrier Reef site. Mapping coral reefs with drones requires taking a series of overlapping images (photogrammetry), so that a map can be reconstructed. As the reader can see, the three images in Figure 2 share significant overlap.

Figure 2: Sample drone mapping images of Bora Bora Southern Barrier Reef.

Figure 3 shows a sample final mapping overlaid onto Google Earth that emphasizes the contrast in resolution between data gathered on drones versus standard satellite imagery.

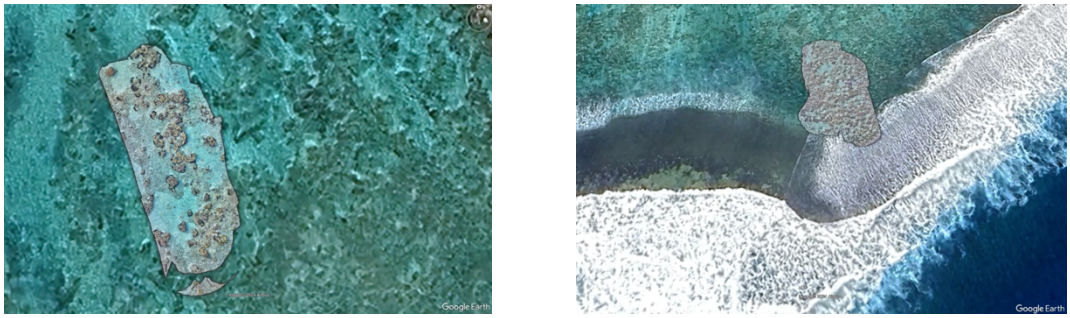

Figure 3: Sample 3D Digital Elevation Models of Bora Bora Southern Barrier Reef overlaid on Google Earth.

Challenges and Outcomes

Despite the advantages of drone imagery, the project faced substantial weather risks. Rain, strong winds, or high-water turbidity can prevent drones from capturing quality images. Given our limited time at each site, favorable weather was crucial.

Fortunately, the weather gods smiled upon us, and we experienced excellent weather conditions, allowing us to capture over 8,000 photos of the target sites. The data will support ongoing reef mapping and monitoring efforts by the CRIOBE lab in Moorea and will be available to the Oxford Seascape Ecology lab to enhance spectral unmixing algorithms for high-resolution coral monitoring.

Presentations and Acknowledgements

At the conclusion of our stint on the Darwin200 voyage, we presented our work on the "World's Most Exciting Classroom," hosted by Joe Grabowski of the Explorer's Club. You can view that episode here: https://www.youtube.com/watch?v=ndMSeMugPBw. We also shared our findings with the crew and passengers of the Oosterschelde.

I am extremely grateful to the IET for supporting my travel through the International Travel Award. Participating in the Darwin200 voyage as a research scientist was a once-in-a-lifetime opportunity. I hope the success of this project and the connections made will lead to future opportunities in coral conservation research.

Finally, I would like to extend deep thanks Josh Clarke, the cameraman on the Oosterschelde, who provided us with invaluable equipment support, as well as Gilles Siu, our contact at CRIOBE. Their support was critical to the success of the project.

Appendix

Figure 4: The Oosterschelde moored in Cook's Bay, Moorea.

Figure 5: Me (left) and my research partner, Tim Lann (right), testing out our drones on Plage de Rohotu in Tahiti.

Figure 6: Holding up the Explorer's Club flag in the crow's nest of the Oosterschelde.