EARTHSCIENCES

Ocean dynamics of Aldabra Atoll

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Key words:	Physical oceanography, modelling, coral reef, biogeochemistry
Research theme(s):	Oceanography, Climate and Palaeoenvironment
Eligible courses for this project:	Preferred: *Interdisciplinary Life and Environmental Science Landscape Award (ILESLA)* With external funding: *DPhil in Earth Sciences (3-4 years)*

Overview

Aldabra is a remote atoll in the southwest Indian Ocean and is one of the most unique places on the planet (Figure 1). This atoll, one of the world's largest, narrowly escaped catastrophe in the 1960s when plans to build a major military base on the island were scrapped. The lease for Aldabra was instead transferred to the Royal Society, largely limiting human activity on the island to research and conservation. Aldabra became part of Seychelles upon independence, with the Seychelles Islands Foundation (SIF) taking over responsibility for island management. Today, Aldabra is a UNESCO World Heritage site and is home to an enormous population of endemic giant tortoises, with human presence largely limited to a small permanent research base.

The sudden geopolitical interest in Aldabra in the 1960s was accompanied by considerable research activity, leading to an initial study into the tidal flushing of its lagoon (Farrow & Brander, 1971). These dynamics are complex as exchange between the enormous lagoon and the open ocean is restricted by a small number of narrow channels. Recently, there has been renewed interest in the hydrodynamics of Aldabra due to the discovery of corals within the lagoon with apparently high thermal tolerance and reproductive success (Koester et al., 2020, 2021). There is hope that these corals could support reef resilience in the face of climate change by dispersing thermally tolerant genes, both within Aldabra and across the southwest Indian Ocean. However, while these connectivity dynamics have been investigated at a regional level (Burt et al., 2024; Vogt-Vincent et al., 2024), our understanding of connectivity

within Aldabra has remained largely unchanged since the 1970s. There is also ongoing research into nutrient dynamics within and outside Aldabra's lagoon (Appoo et al., 2024) but, again, this work is limited by a poor understanding of the lagoonal hydrodynamics.

Figure 1: Satellite view of Aldabra, showing the large lagoon (c. 30 km across) and narrow channels connecting the lagoon to the ocean. *Image: NASA Earth Observatory, USGS.*

Methodology

This project will primarily use **ultra-high resolution hydrodynamic models** to comprehensively investigate the tidal flushing of Aldabra lagoon, and the hydrodynamics of flow around the island. The primary goal will be to generate detailed maps for currents, tidal elevation, and water residence time across the lagoon. Depending on the student's interests, the project could further explore applications for ecological connectivity through larval dispersal, biogeochemistry, effects of sea-level rise, or upwelling associated with the island mass effect. The university has strong links with the Seychelles Islands Foundation, and the project would involve working closely with SIF to ensure that deliverables are useful in a conservation context. Depending on funding and resource availability, fieldwork to ground-truth models (e.g. the deployment of an ADCP) may be possible but is not guaranteed.

As the project will be largely computational, it would suit a student with a strong quantitative background and broad interests in physical oceanography and ecology/conservation. Potential applicants are advised to contact project supervisors to discuss their application.

Timeline

Year 1: Training in hydrodynamic modelling (e.g. CROCO, Delft3D), start configuring simulations.

Years 2 and 3: Run simulations and perform further analyses depending on student interests and stakeholder priorities.

Year 4: Complete analyses, communicate results (international journals, conferences, stakeholders), complete thesis.

Training & Skills

The student will be trained in running high resolution hydrodynamic models, analysing oceanographic (model and observational) data, scientific writing, and fieldwork if relevant.

References & Further Reading

Farrow and Brander, 1971. Tidal Studies on Aldabra. Philos. Trans. R. Soc. B, 260, pp. 93-121. doi:10.1098/rstb.1971.0008.

Grimaldi et al. 2024. Local coral connections within an atoll reef system underlie reef resilience and persistence. Limnol. Oceanogr, 69. pp. 3020-3032.

Koester et al. 2021. First insights into coral recruit and juvenile abundances at remote Aldabra Atoll, Seychelles.

Vogt-Vincent et al. 2024. Coral reef potential connectivity in the southwest Indian Ocean. Coral Reefs, 43. pp. 1037-1051. doi:10.1007/s00338-024-02521-9

Further Information

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