DECADAL EVOLUTION OF CORAL ISLANDS IN A CHANGING OCEAN AND CLIMATE

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BACKGROUND

Coral reef islands are under threat from warming and rising seas, ocean acidification and increased storminess. Coral islands are low-lying accumulations of sediment derived from the shells and skeletons of calcifying reef organisms. IPCC predications and COP26 highlight that the future of coral islands is not certain as islands are morphologically active. Their decadal evolution has been studied in the Indo-Pacific with the majority (85% of 709 islands) either stable and/or accreting, while the rest (15%) are shrinking (Kench et al., 2018). It is unclear what tipping points are causing negative impacts on some coral reef islands and not others. A better understanding of island stability and vulnerability is urgently needed. This has direct implications for over 200 million people that rely on reefs and their islands for their livelihoods (Ferrario et al., 2014). Further, coastal States such as Australia, USA, the Philippines and Small Island Developing States (SIDS) use coral reef islands as legal baselines to support their maritime jurisdictions (UNCLOS, 1982).

STUDY AREAS AND METHODS

We focus on 31 of Australia's offshore coral reef islands on 10 reefs across the Coral Sea and NW Shelf (Figure. 1). These islands are environmentally and geo-politically important as they support and extend Australia's maritime jurisdiction. Island morphology (e.g., shoreline positions, areas, shapes) in historical aerial and satellite imagery (1977-now) were compared to ocean and climate data (e.g., storm tracks, NOAA Coral Watch). We used this data to identity tipping points that drive decadal changes in coral reef island stability.

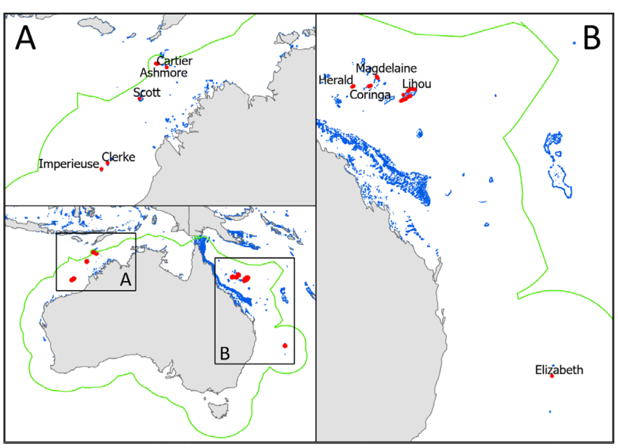

Figure 1 – Australia's offshore coral reef islands. (A) NW Shelf and (B) Coral Sea. Island locations (red), coral reefs (blue) and the boundary of Australia's maritime zones (green line).

PRELIMINARY RESULTS AND DISCUSSION

Nine islands (29%) were stable, 15 islands (48%) increased in size and 7 islands (23%) reduced in size. At Lihou (Coral Sea) area reductions were < 35%. We suggest tipping points at Lihou are high cyclone frequency and small unvegetated morphology. At Ashmore (NW Shelf) islands increased in size (< 15 %), migrated and rotated (Figure. 2). We suggest tipping points at Ashmore are cyclones, marine heatwaves and sea-level rise. For example, two cyclones passed over the reef (1981, 1990) in directions that support the shifts in island location and orientation (Figure. 2). While repeated marine heatwaves (n=49; 1985-2021) may have temporarily increased the amount available sediment due to coral bleaching and mortality. Further, the high rates of sea-level rise (4.6 mm/yr; 1993-2021) and energetic waves observed may be responsible for transporting additional sediments to island shores.

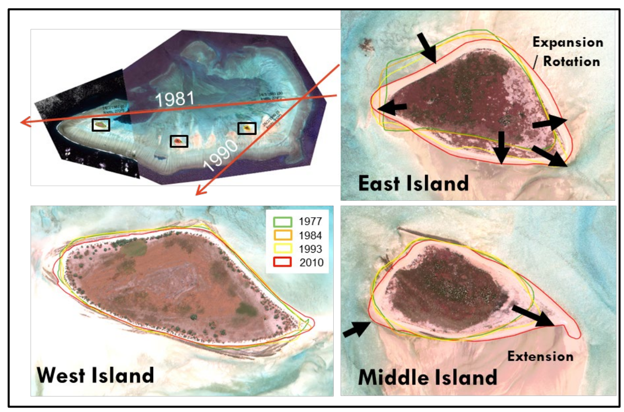

Figure 2 – Ashmore Reef, NW Shelf (1977-2010) showing decadal shoreline behaviours and two cyclone tracks.

We identify climate and ocean tipping points responsible for constructive and destructive impacts on coral reef island stability. Understanding how islands behave is paramount for managing their continuing survival. Loss of any coral islands will have serious social, environmental and geo-political consequences for millions worldwide.

REFERENCES

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