Climate change impacts on coastal ecosystems – evidence from Australia's Great Barrier Reef and mangroves

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Overview

- Two examples of massive environmental change
  - Coral bleaching along the Great Barrier Reef in eastern Australia
  - Mangrove dieback in Kakadu National Park in northern Australia

- World Heritage listed sites – iconic conservation parks subject to threat of international sanction (World Heritage in Danger)

- Changes in the ecology and ecosystem services or benefits available to local people and visitors

- Drivers – global climate change (?)

- Responses – international policy action

Kakadu National Park

Great Barrier Reef

Coral bleaching

Coral bleaching occurs when abnormal environmental conditions, like heightened sea temperatures cause corals to expel tiny photosynthetic algae, called ‘zooxanthellae’.

The loss of these colourful algae causes the corals to turn white, and ‘bleach’.

Bleached corals can recover if the temperature drops and zooxanthellae are able to recolonise them, otherwise the coral may die.

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Surveying healthy reefs

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Bleached corals

Graveyard of Staghorn coral, Yonge reef, Northern … Reef Studies.jpg

June 2017

Australian Government

Great Barrier Reef
Marine Park Authority

FINAL REPORT

2016 CORAL BLEACHING EVENT
on the Great Barrier Reef

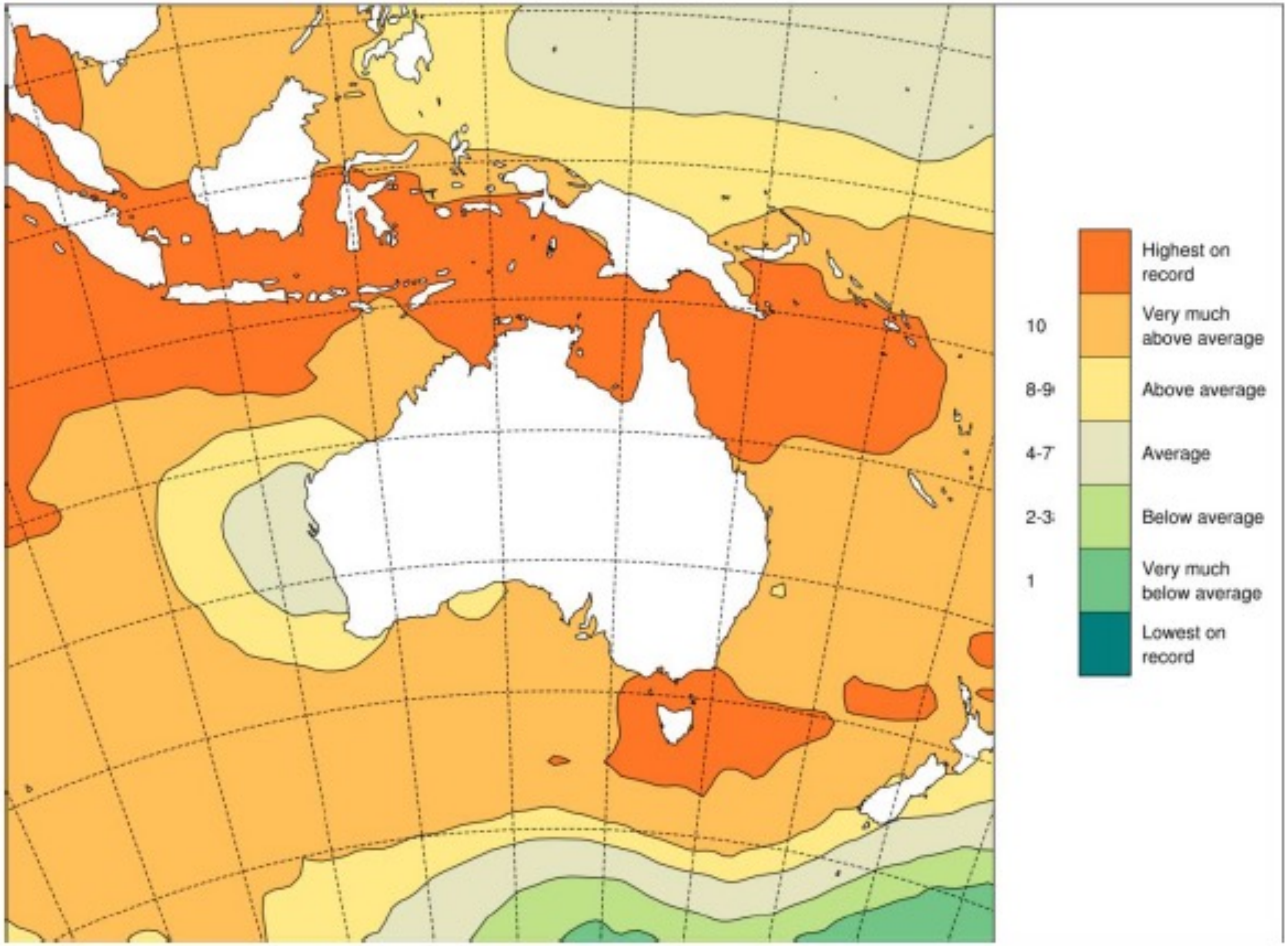


Figure 1 Distribution of record-breaking sea surface temperatures around Australia from 1 January to 31 March, 2016.

Note: "Highest on record" refers to highest sea surface temperature value since 1900. Decile 10 is the highest 10 percent of records — this category is 'very much above average'. Analysis supplied by the Bureau of Meteorology. Based on the ERSST v4 dataset produced by the National Oceanic and Atmospheric Administration. © Australian Bureau of Meteorology

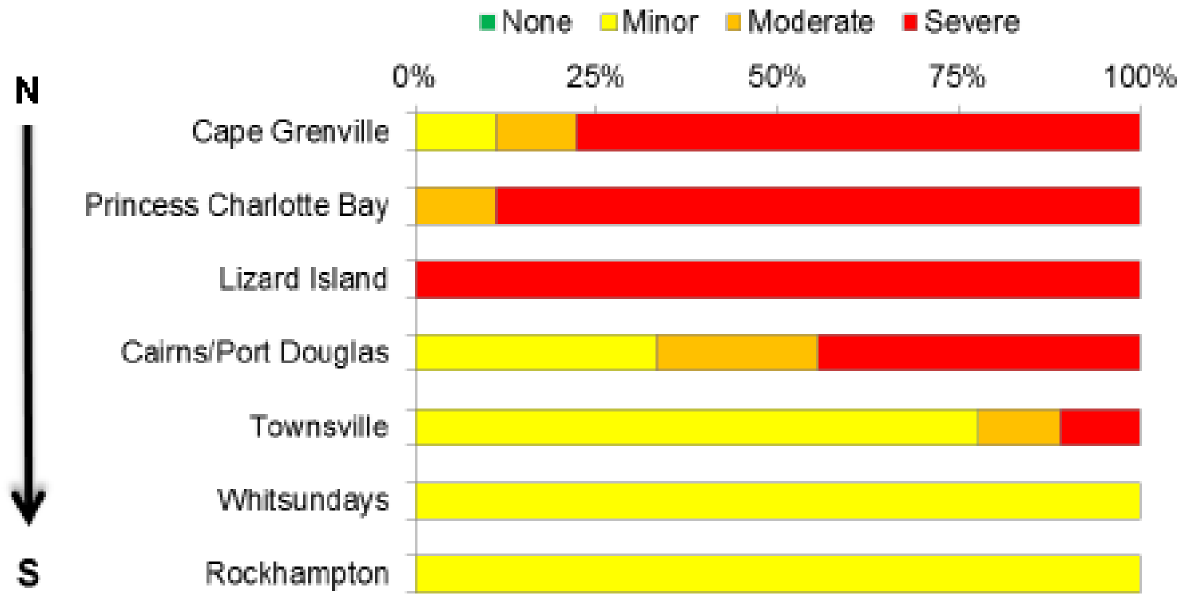


Figure 6 Illustration of the proportion of reefs within each transect that exhibited either no, minor, moderate or severe bleaching. Data are from Round 1 RHIS surveys of 62 reefs.

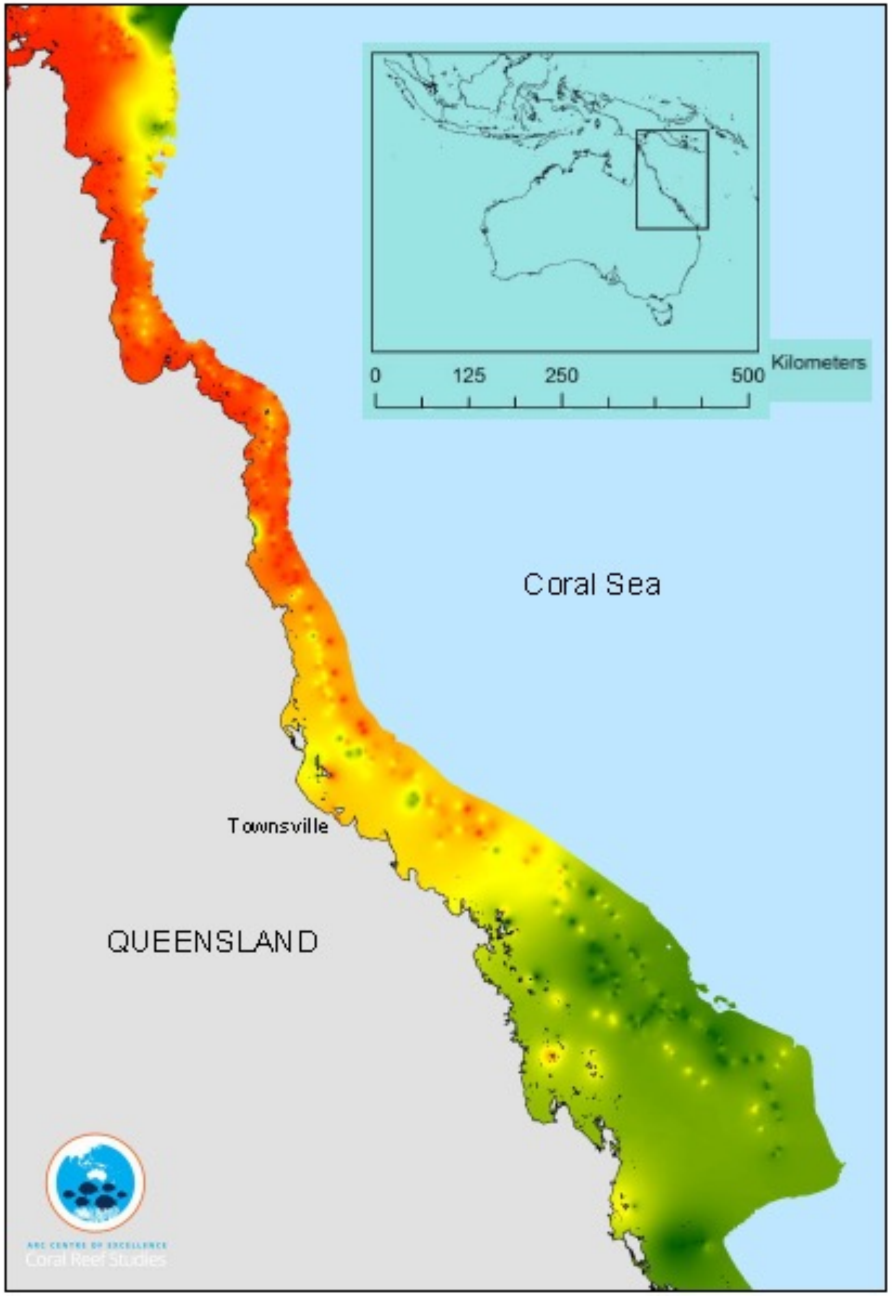


Figure 3 Map showing aerial survey results of coral bleaching during the peak of the bleaching e
in March 2016. Source: Australian Research Council Centre of Excellence for Coral Reef Studies

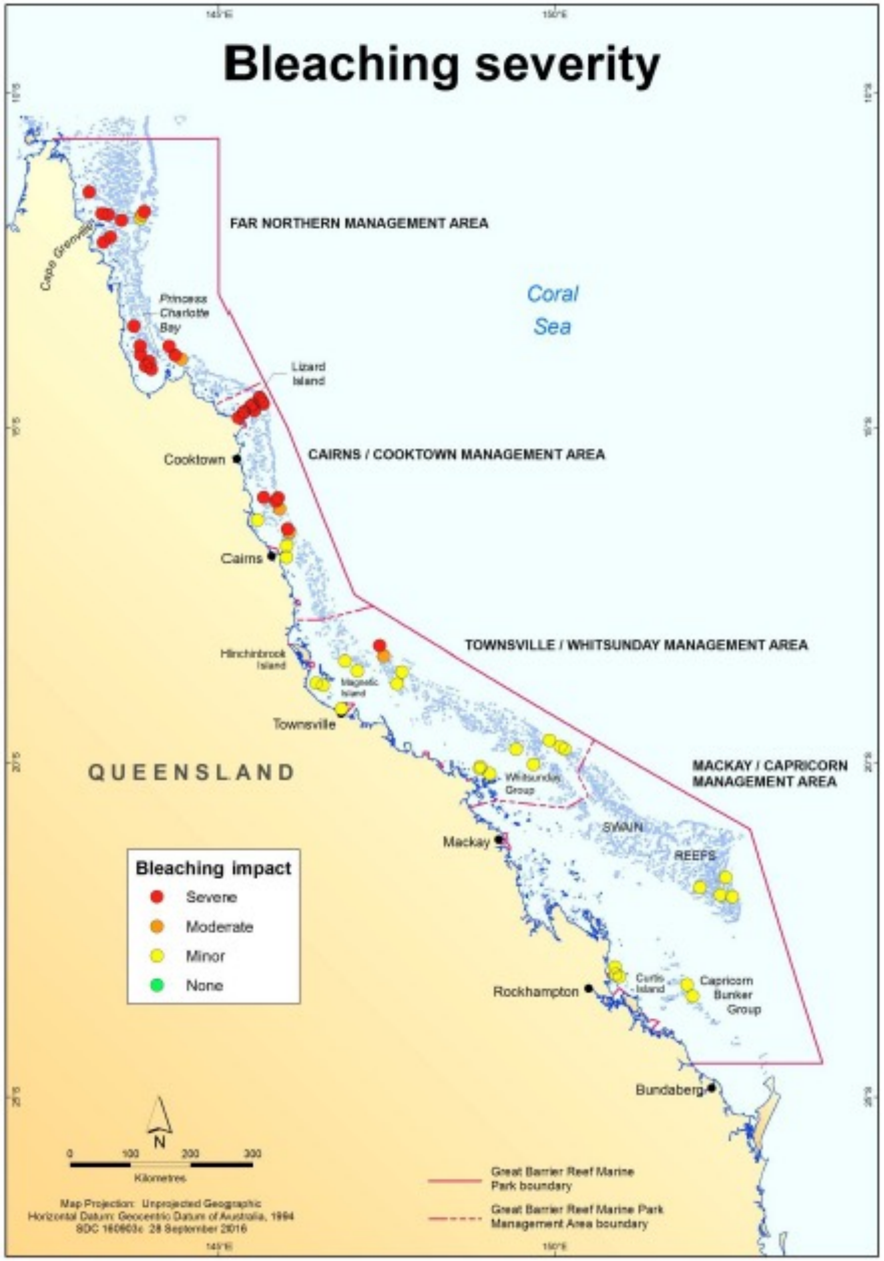
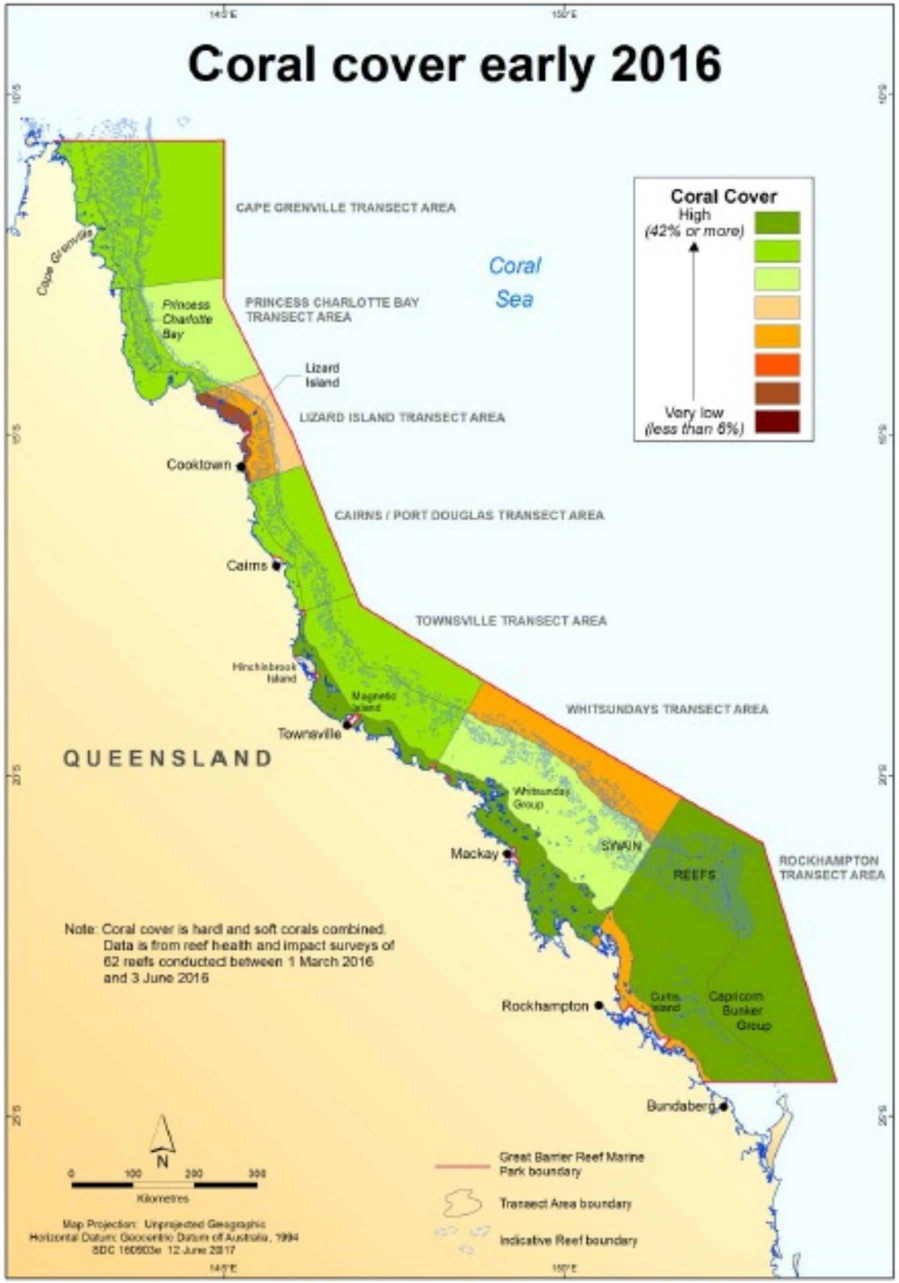


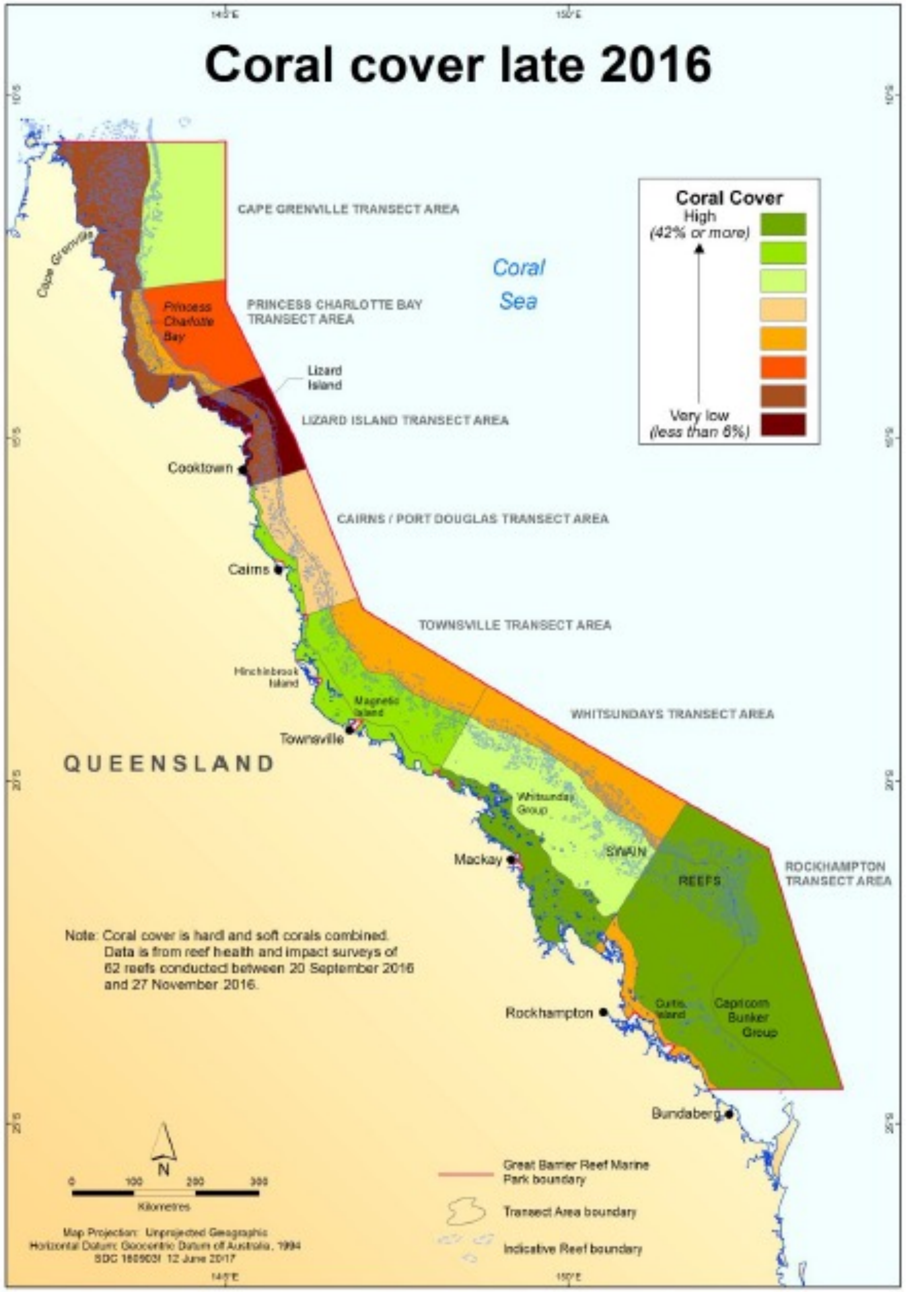
Figure 5 Reef-wide pattern of bleaching severity impacts on the Great Barrier Reef in 2016 on 62 reefs surveyed using the RHIS method. Each circle represents a survey reef and colours indicate severity category, with red indicating the most severely impacted reefs. See Appendix B for descriptions. Data are from Round 1 reef health and impact surveys (March to June 2016).



Note: Coral cover is hard and soft corals combined. Data is from reef health and impact surveys of 62 reefs conducted between 1 March 2016 and 3 June 2016

Figure 11 Estimated coral cover as at early 2016 on the Great Barrier Reef.

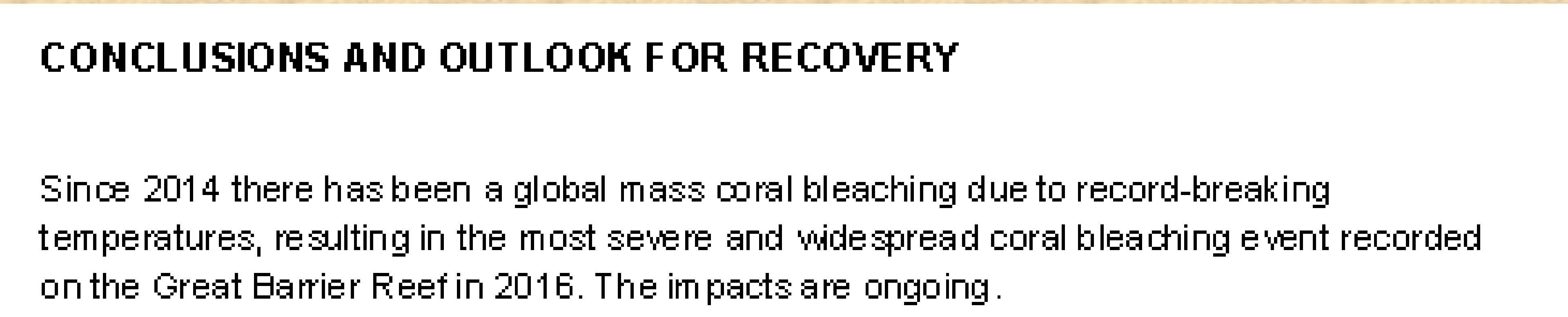
The colour scale represents indicative coral cover (from high to very low) using estimated averages (means) for surveyed reefs



Note: Coral cover is hard and soft corals combined. Data is from reef health and impact surveys of 62 reefs conducted between 20 September 2016 and 27 November 2016.

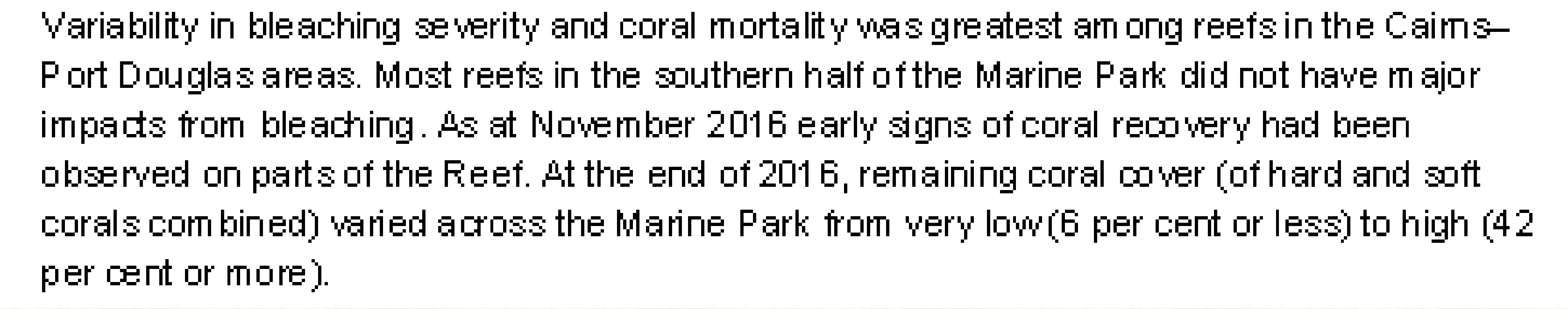
Figure 12 Estimated coral cover as at late 2016 on the Great Barrier Reef.

The colour scale represents indicative coral cover (from high to very low) using estimated averages (means) for surveyed reefs.

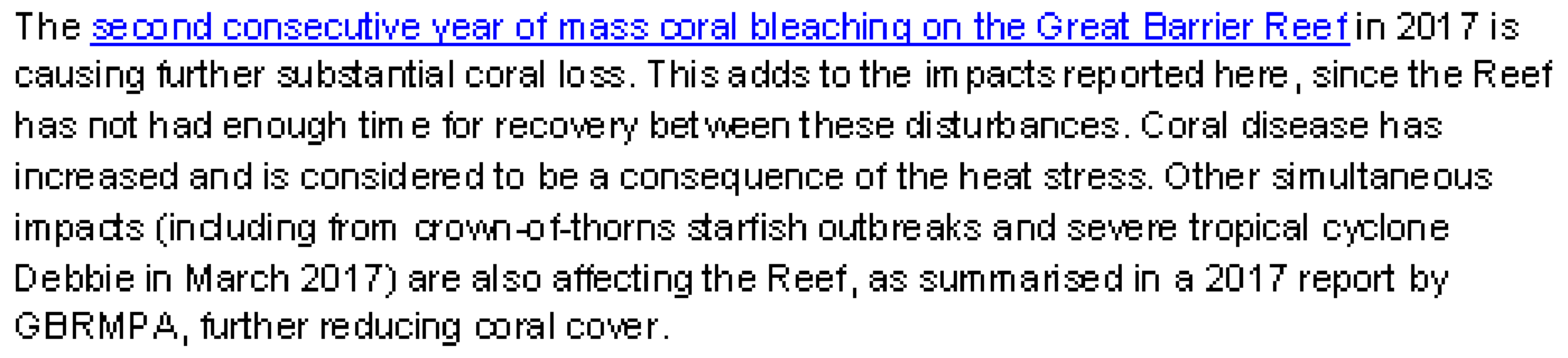


CONCLUSIONS AND OUTLOOK FOR RECOVERY

Since 2014 there has been a global mass coral bleaching due to record-breaking temperatures, resulting in the most severe and widespread coral bleaching event recorded on the Great Barrier Reef in 2016. The impacts are ongoing.



Variability in bleaching severity and coral mortality was greatest among reefs in the Cairns–Port Douglas areas. Most reefs in the southern half of the Marine Park did not have major impacts from bleaching. As at November 2016 early signs of coral recovery had been observed on parts of the Reef. At the end of 2016, remaining coral cover (of hard and soft corals combined) varied across the Marine Park from very low (6 per cent or less) to high (42 per cent or more).



The second consecutive year of mass coral bleaching on the Great Barrier Reef in 2017 is causing further substantial coral loss. This adds to the impacts reported here, since the Reef has not had enough time for recovery between these disturbances. Coral disease has increased and is considered to be a consequence of the heat stress. Other simultaneous impacts (including from crown-of-thorns starfish outbreaks and severe tropical cyclone Debbie in March 2017) are also affecting the Reef, as summarised in a 2017 report by GBRMPA, further reducing coral cover.

The severity of this bleaching event reinforces the urgent need for the strongest possible global action on climate change, and strong local action to improve the resilience of the Reef ecosystem.[31,55] From a coral reefs perspective, it is critical to limit global temperature rise to no more than 1.5 degrees Celsius above pre-industrial levels, and preferably less (noting average global temperatures are already approaching 1 degree Celsius).[56,57,58] This requires much greater emissions reduction efforts globally than currently pledged by nations around the world.

Through the Australian and Queensland governments' Reef 2050 Long-Term Sustainability Plan, significant investment is being made to restore the integrity of Reef catchments and improve water quality entering the Reef. This is in addition to work that has been taking place since 2003 to reduce nutrients, pesticides and sediments in farm run-off. Considerable efforts are also being made under the plan to reduce the impacts of other pressures to help reefs cope with or recover from disturbances.

While these actions to reduce pressures and build resilience remain crucial, environmental management efforts can only compensate for reduced coral reef resilience in the face of climate change to a limited extent and over a limited timeframe.[59]

NEWS

Coral bleaching: Researchers struggle to find anywhere in Pacific Ocean untouched

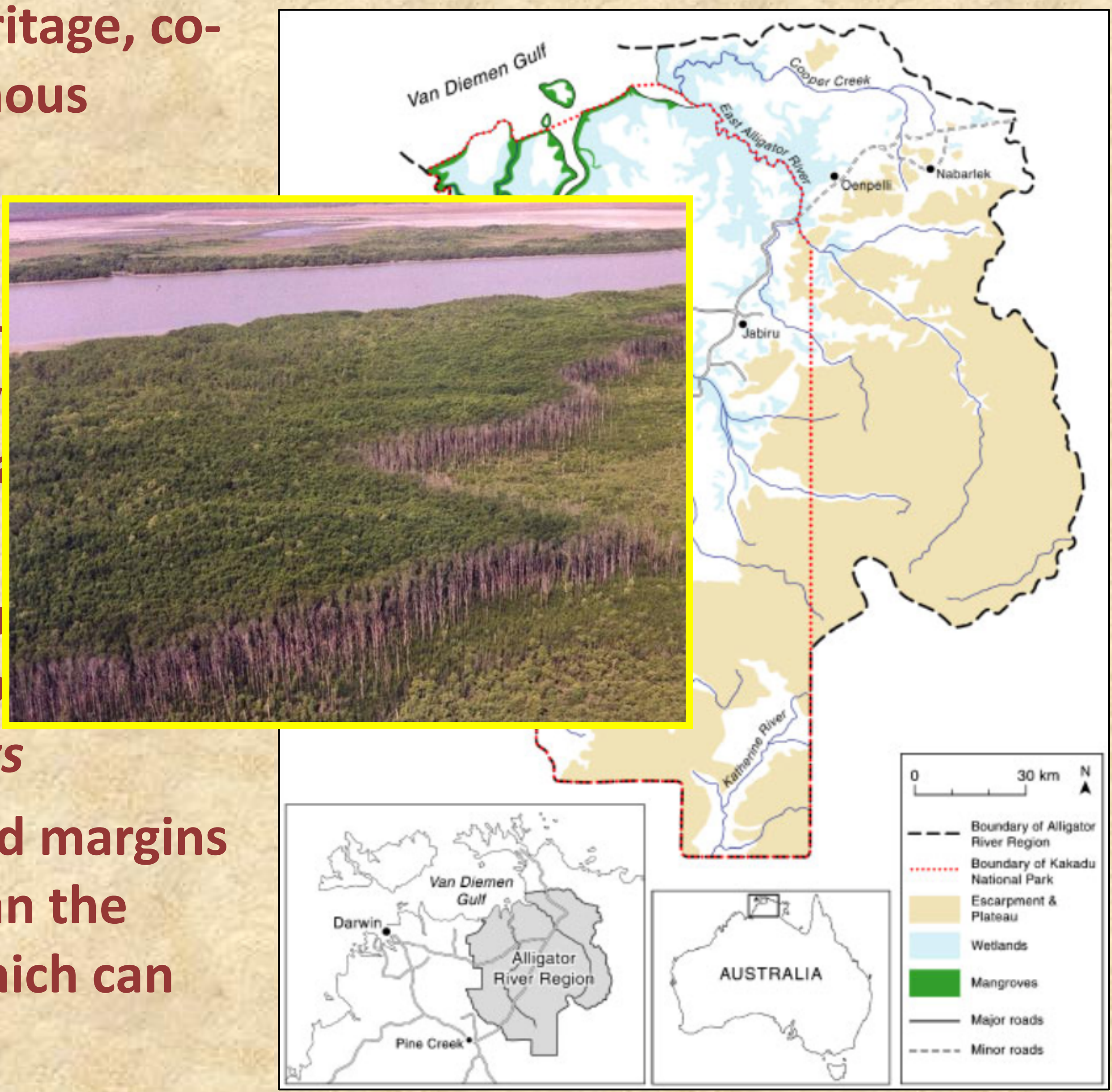
Mangroves and Climatic Fluctuations

- Dieback of mangroves along much of the northern Australian coastline in 2015/2016 ca. 10,000 ha
- Concerns about the impact of climate-related phenomena on the long-term integrity and viability of this ecosystem
- Primary drivers of change are:
  - Fluctuations in sea level
  - Rising temperatures
  - Increased storm intensity and frequency
  - Changes in rainfall and inundation

Duke et al. 2017. *Marine and Freshwater Research*

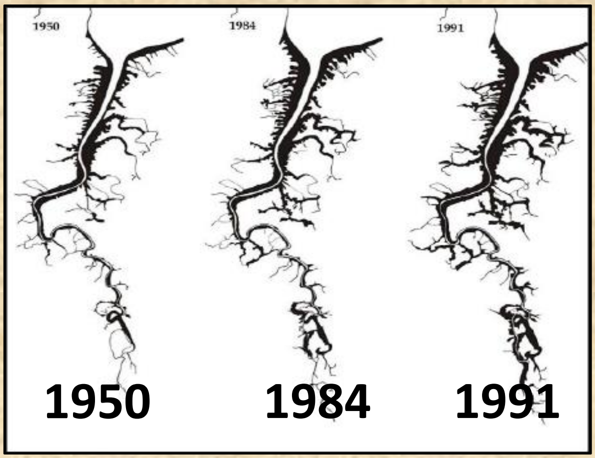
Beyond the Gulf: Kakadu National Park

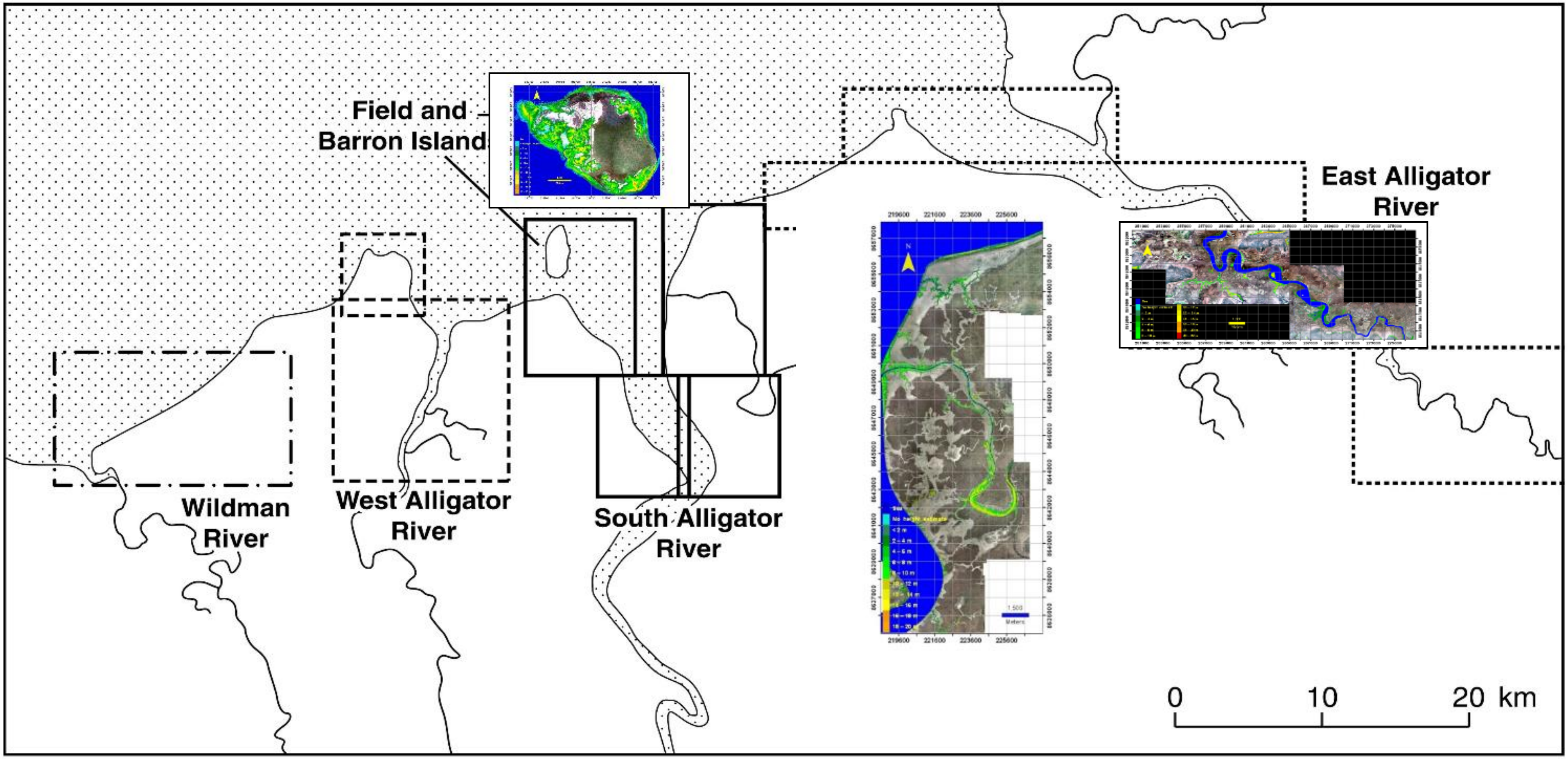
- Iconic park, World Heritage, co-managed with indigenous owners; 20,000 ha
- Landsat data in 2000 - mangroves occupied 1
- Occurred along the riv the coastline of the ma and islands
- Dominated by *Avicenn* *Rhizophora stylosa, So* *alba* and *Mixed Forests*
- Landward and seaward margins are typically lower than the intermediate zone, which can exceed 25 m in height

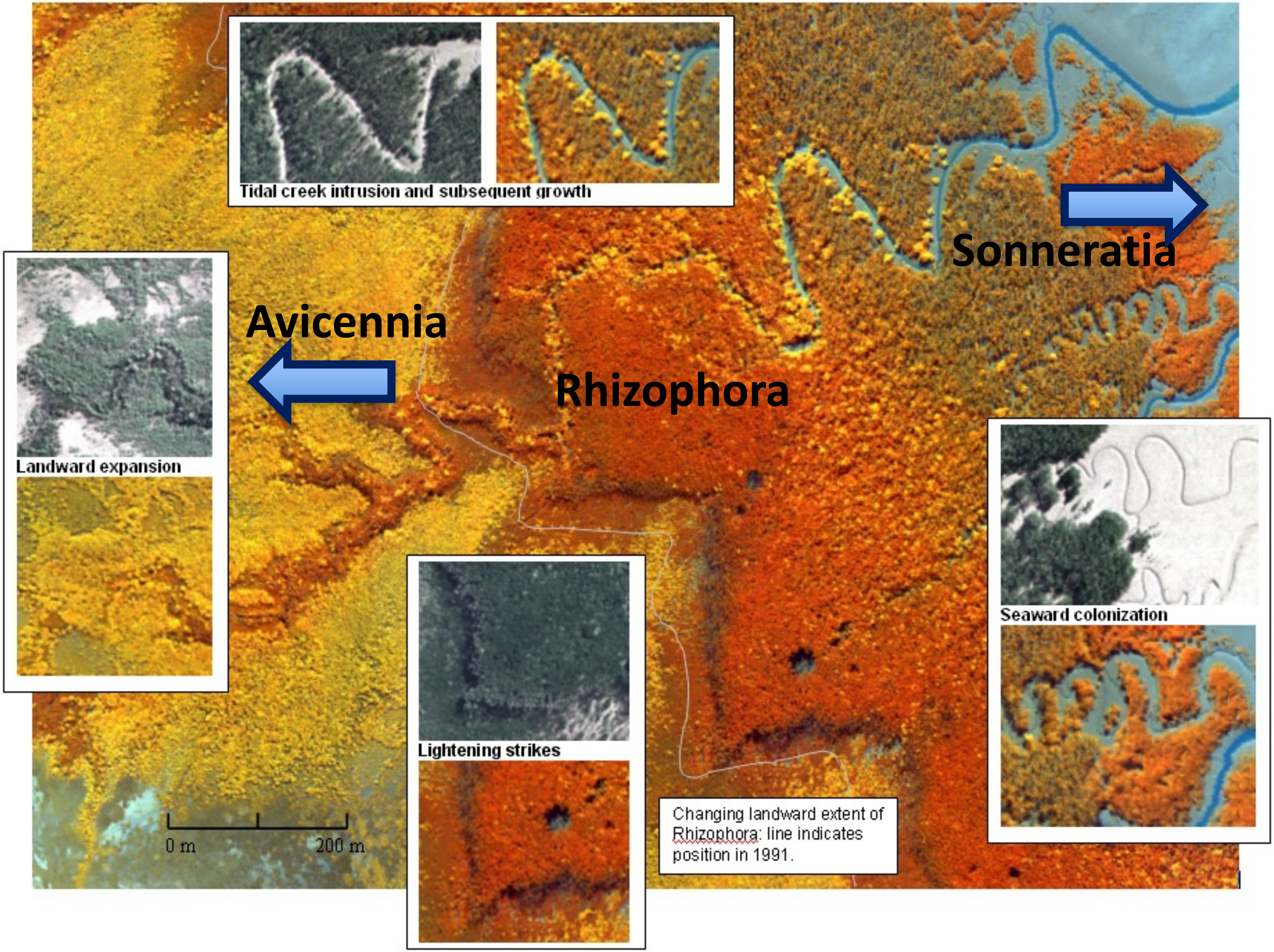


Kakadu mangrove baselines - extent and height

(1m orthomosaics & DEMs)







Tidal creek intrusion and subsequent growth

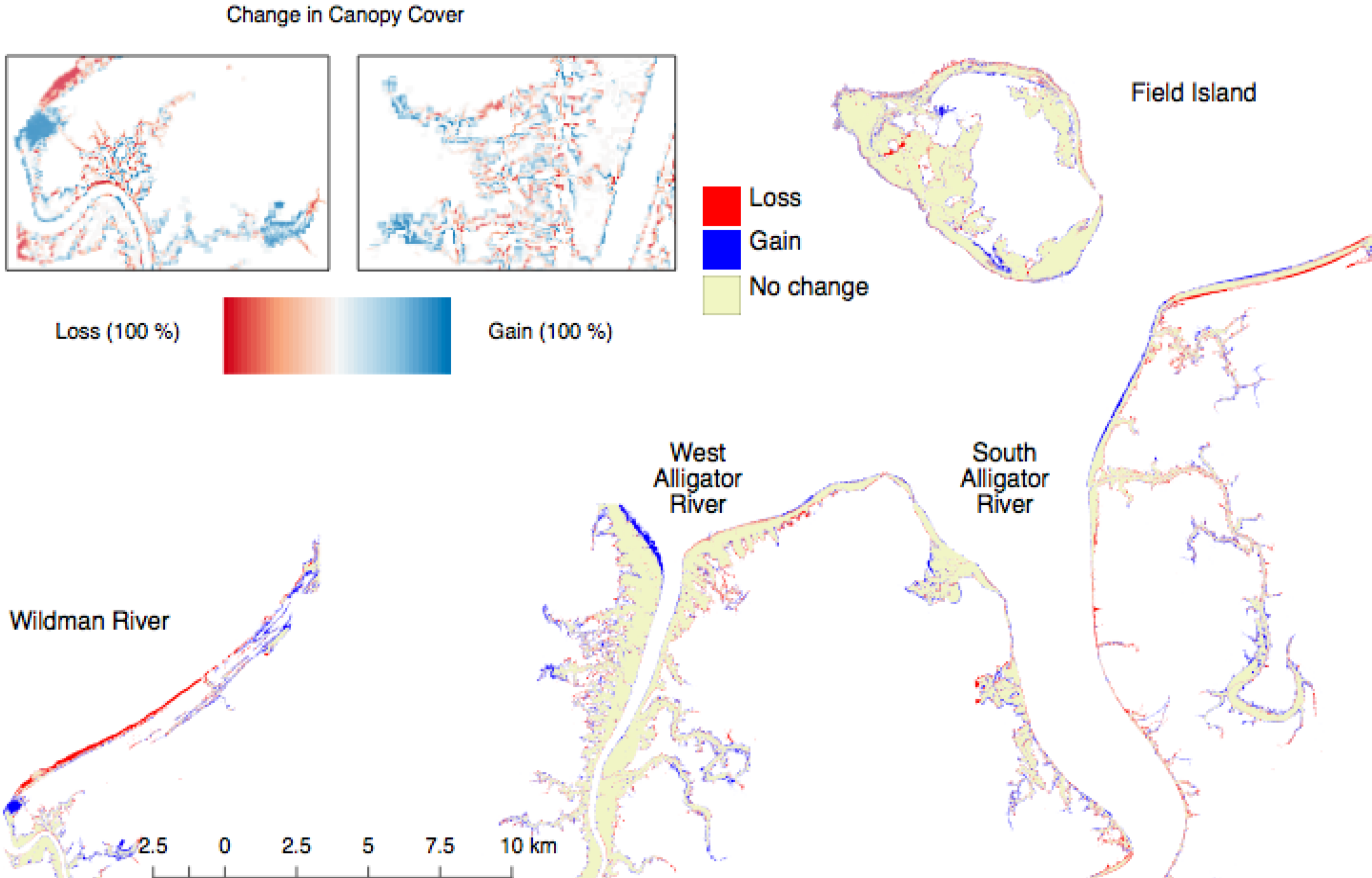
Landward expansion

Lightening strikes

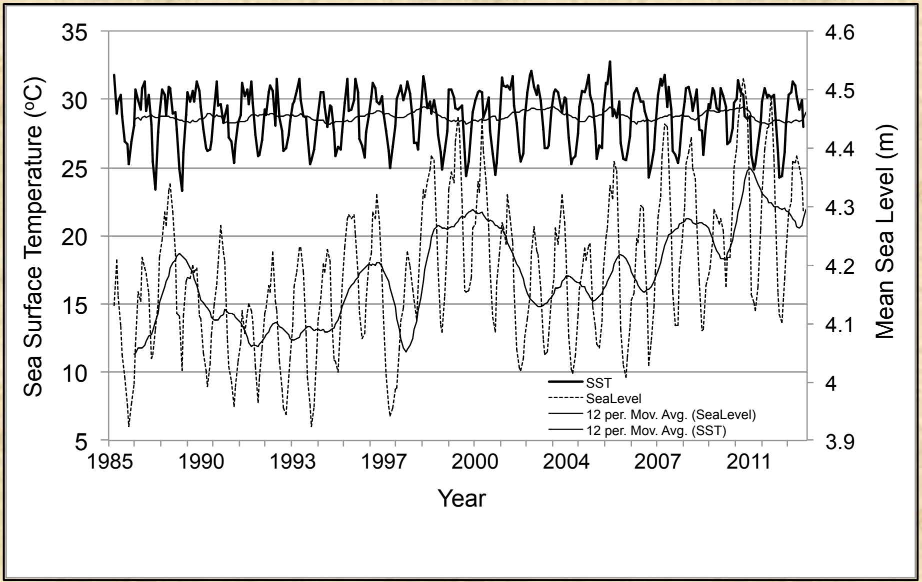
Seaward colonization

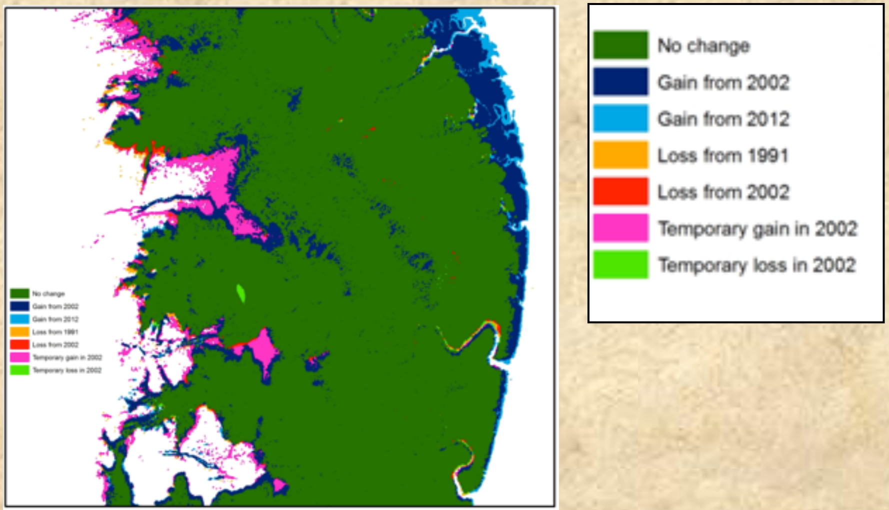
Changing landward extent of Rhizophora: line indicates position in 1991.

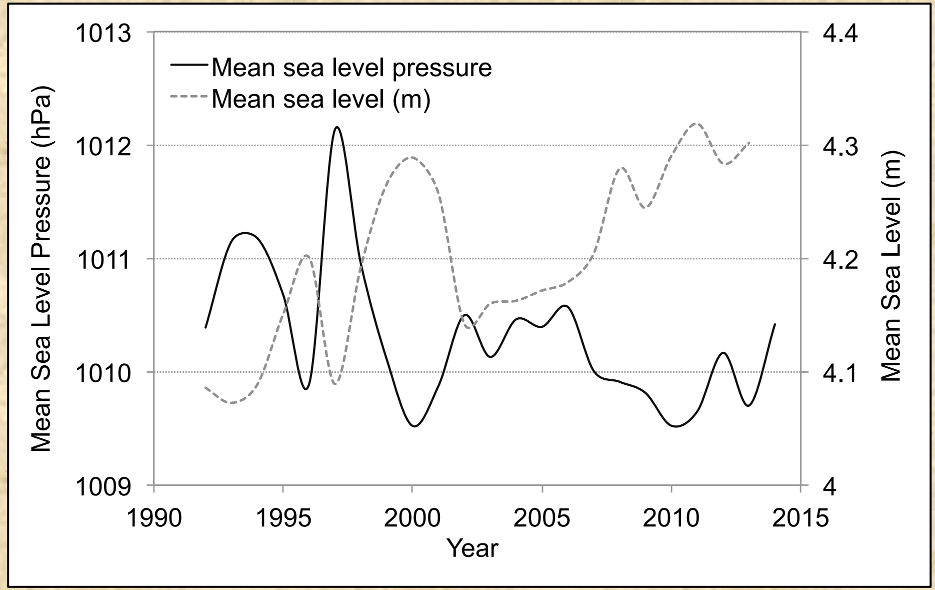
Changes in mangrove extent and cover between 1991 and 2012, Kakadu National Park

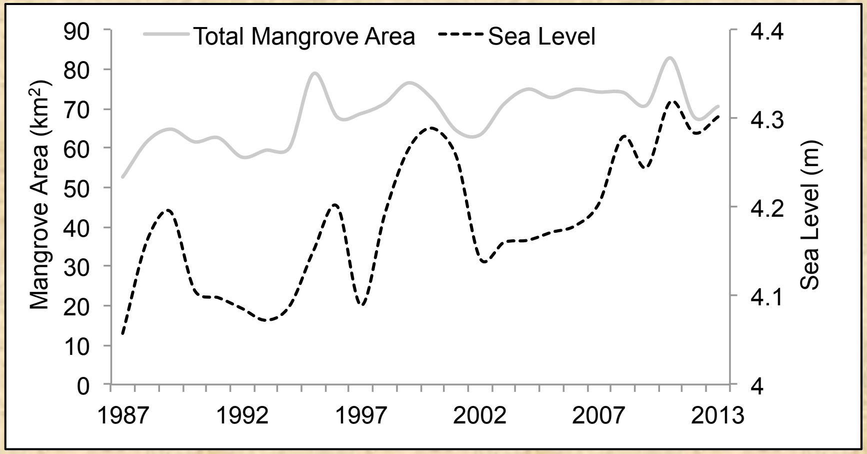


Historical Temperature and Sea Level Fluctuation









Landsat-derived estimates of area with Foliage Projective Cover of > 30 % for the West Alligator River mangroves

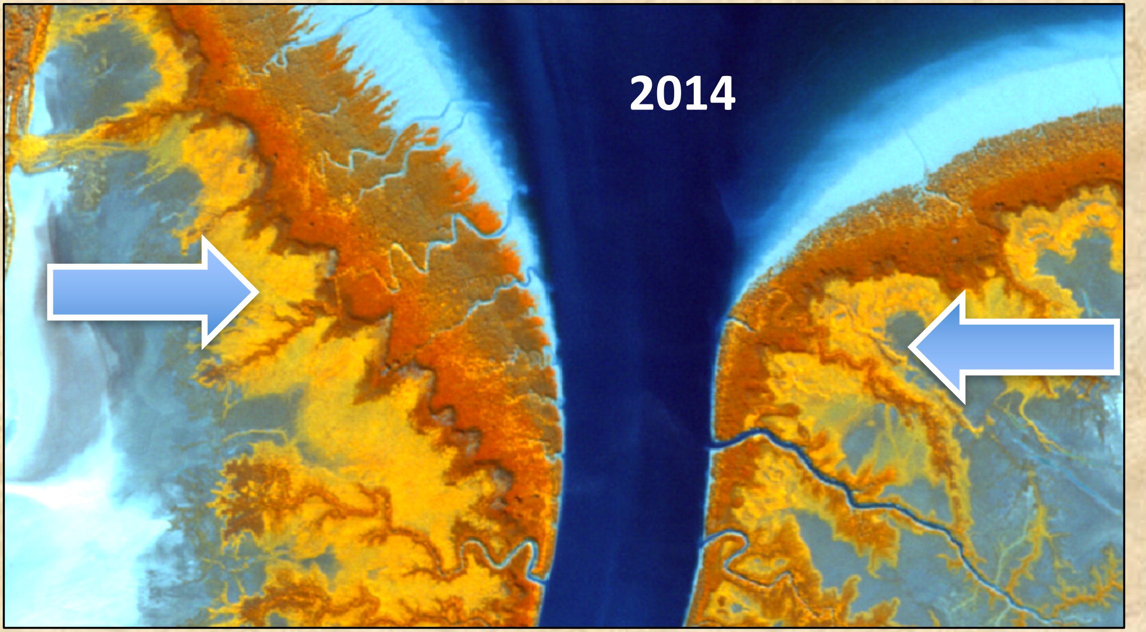
Mangrove dieback in Kakadu NP (2014-2016)

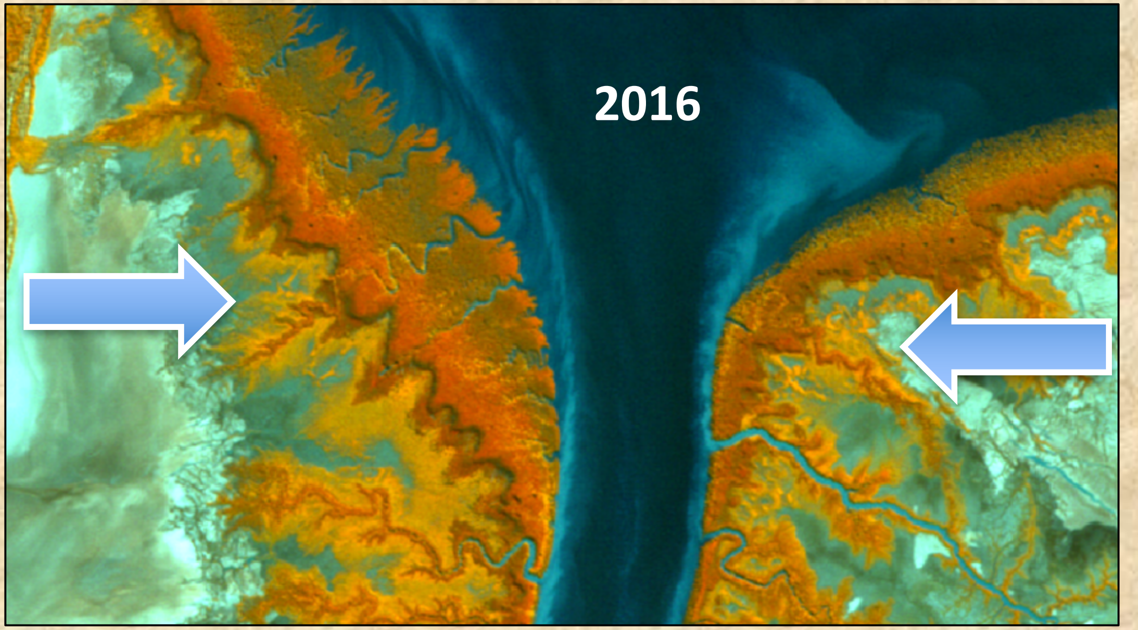
Ground and Drone Observations of Mangroves Kakadu NP

During September, 2016, a field campaign using combinations of drone and airborne survey to establish the characteristics of mangroves occurring in the upper reaches of creeks in terms of structure and species composition

Significant dieback was observed. 24.73 km^2 dieback / 21% of total area

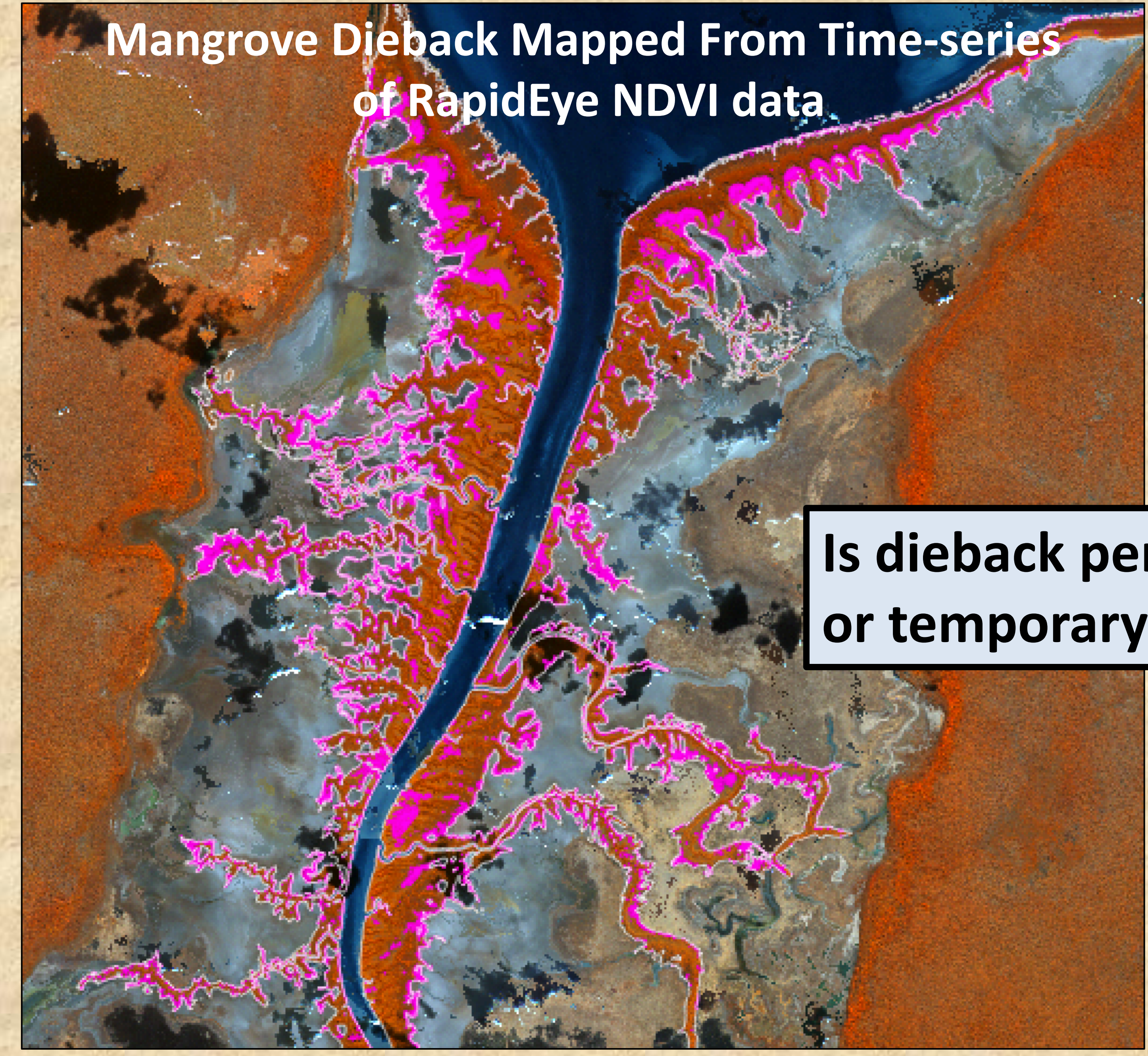
Time-Series of Rapid Eye Data, Kakadu NP





- Dieback is in areas dominated by *Avicennia marina*
- Most mangroves are of relatively low (< 5 m) stature
- The majority occurs on the inland sections

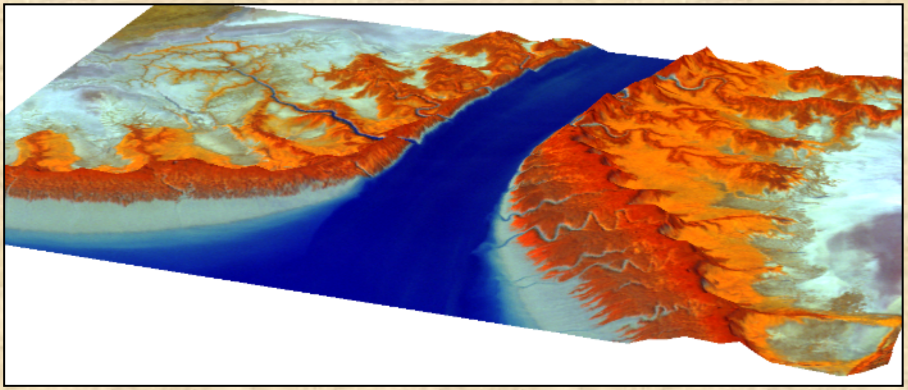
Mangrove Dieback Mapped From Time-series of RapidEye NDVI data



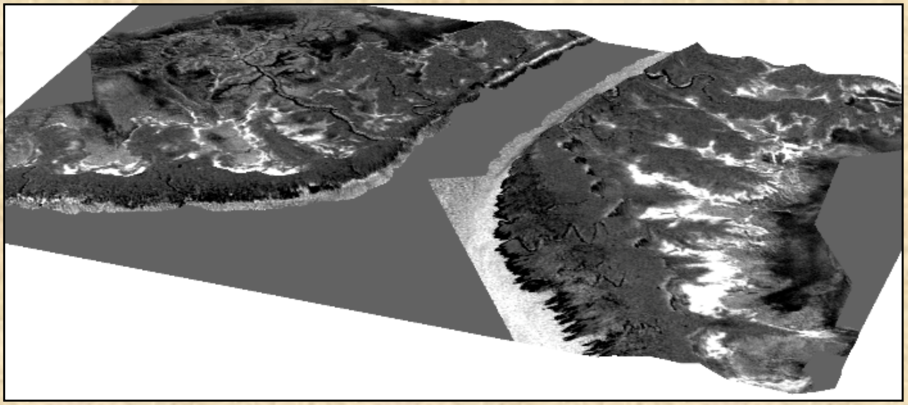
Is dieback permanent or temporary? Cyclic?

🟪 Mangrove dieback in 2016 from a 2014 baseline

Integration of LIDAR and RapidEye, Kakadu NP



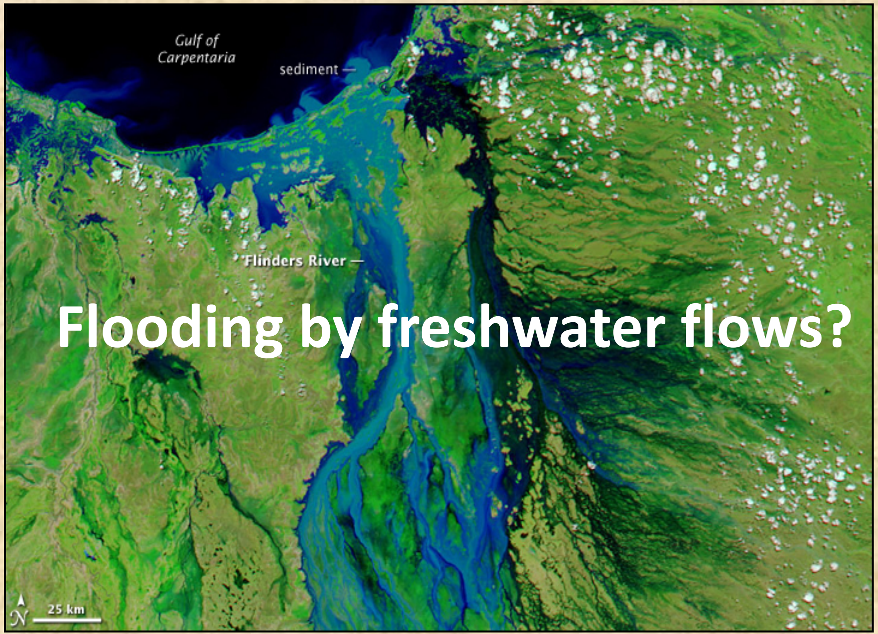
RapidEye NIR, Red Edge and Red Reflectance Bands showing dominance of *Avicennia marina* (landward edge), *Rhizophora stylosa* (central zone) and *Sonneratia alba* (seaward edge)



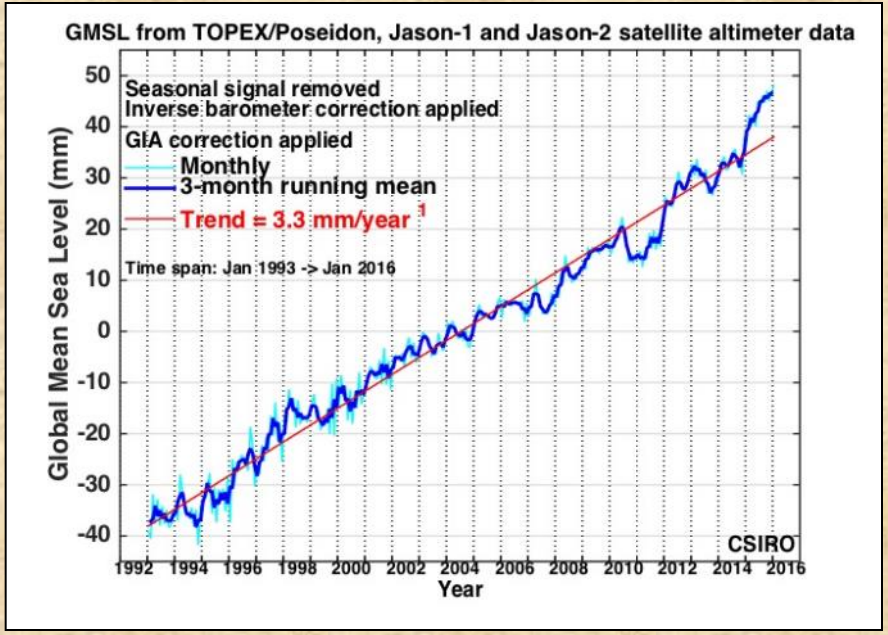
Comparison of the RapidEye NDVI from 2014 and 2016 indicates extensive dieback in low (< 5 m) stature forests dominated by *A. marina*.

Observations of mangrove dieback (primarily *A. marina*) observed from helicopter in September 2016

Causes and Consequences of Change?

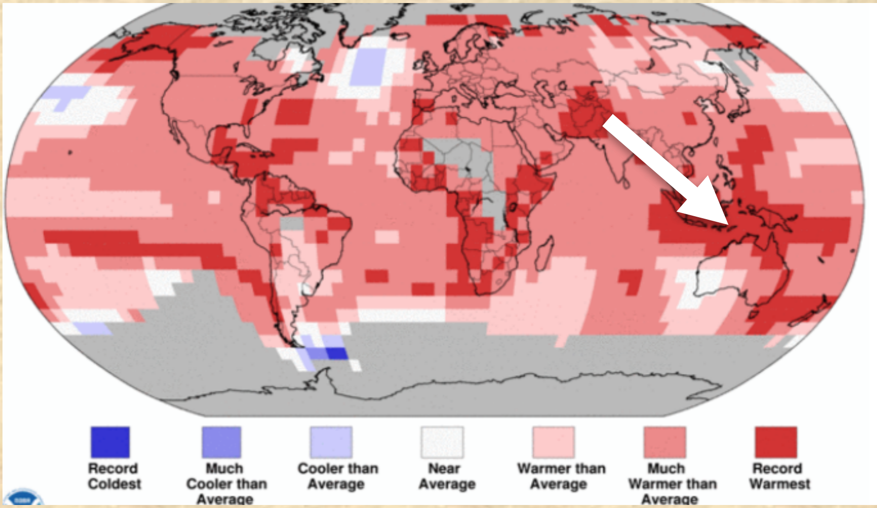


Flooding by freshwater flows?



Sea level rise / changes in tides?

Causes of the change can be attributed to an adverse deviation in prevailing environmental conditions and may be a consequence of human-induced climate change – temperature, rainfall and flooding, tidal depression……



Increasing temperatures?

Conclusions - mangroves

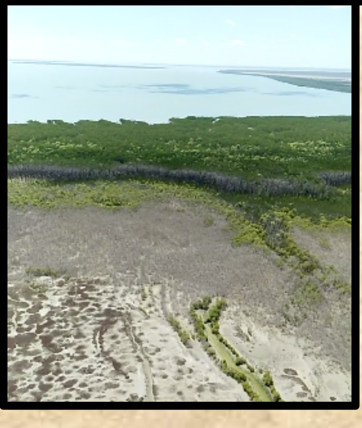
- Recent dieback event in Kakadu NP defied the trends of mangrove expansion that had been observed in previous decades

- The extent of dieback is worrying because all mangroves in Australia have a high degree of protection and those in the north have not been cleared or significantly degraded by humans

- Whilst there has been justified alarm about the dieback of mangroves, we have evidence that such changes might have occurred in past decades, albeit not to the same severity, extent and rapidity, or have been noticed

- May even have been more severe changes in the past ….. with expected rise in sea level the mangroves are expected to recover and extend further inland into the adjoining freshwater wetlands

Management options for tropical reefs and mangroves



- **Local restoration and management actions to build resilience; knowledge based**

NEWS

Paris accord: Syria plans to join climate agreement, leaving US only country opposed

Updated Wed 8 Nov 2017, 7:30pm

- **National / International policy responses beyond local politics & economies**

PM

Monday to Friday from 6:05pm on ABC Local Radio and 5:00pm on Radio National.

Environmentalists raise fears about progress of Adani coal mine