Why are Mangroves expanding into Saltmarshes in eastern Australia?

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Outline

- Establishing encroachment
- Factors that may influence encroachment
- Aim of the research
- Methods
- Results
- Conclusion

Mangroves encroaching into saltmarsh

This is leading to regional decline in salt marsh area throughout eastern Australia

How are they encroaching?

- There has been much research* along the eastern seaboard of Australia showing mangrove expansion at the expense of salt marsh

Mangroves (Avicennia)

Saltmarsh (Sporobolus/ Sarcocornia

E.g., McTainsh et al. 1986, Saintilan & Williams 1999, Saintilan & Wilton 2001, Jones et al. 2004

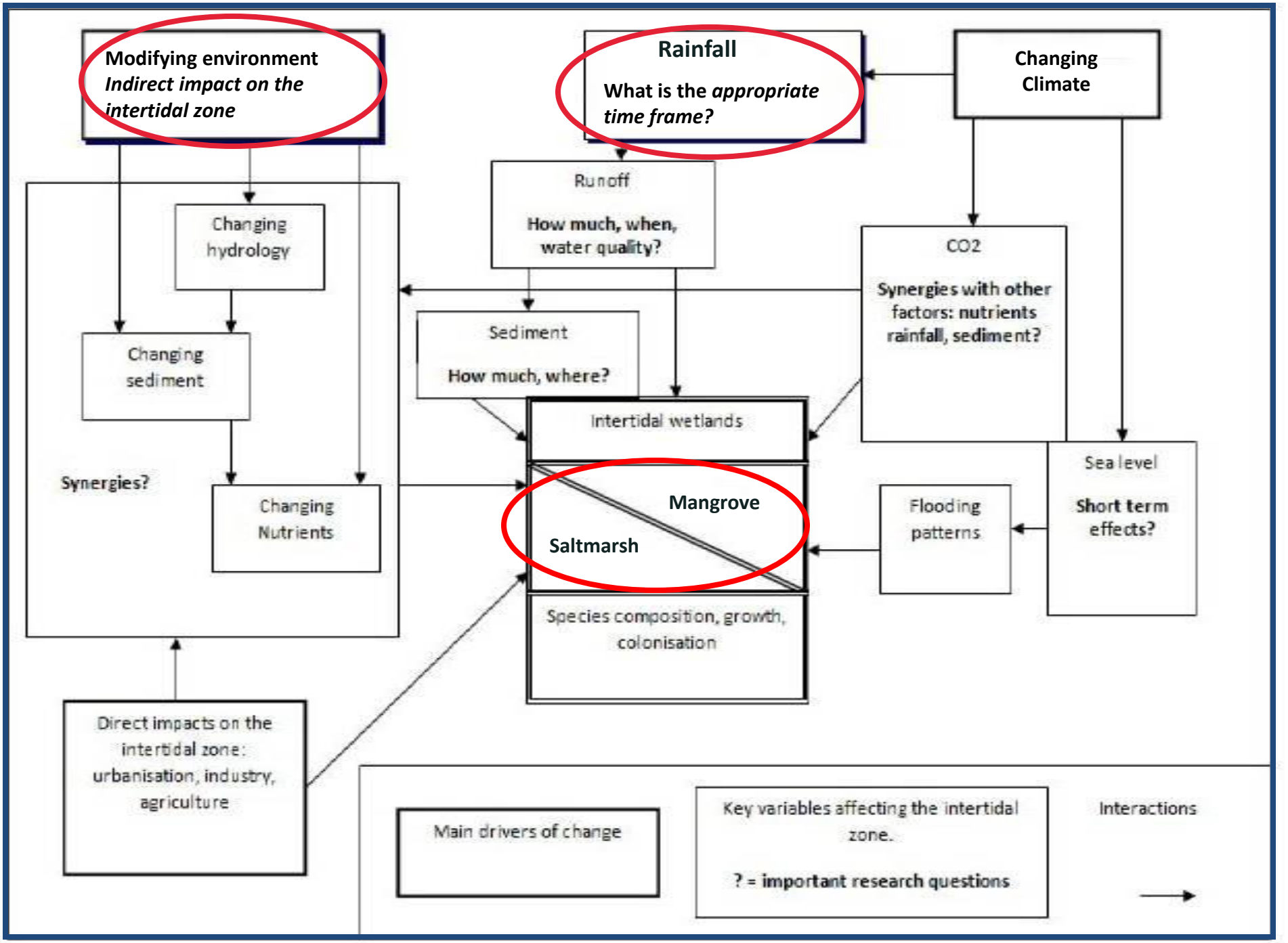
Salt marsh losses of up to 100% have been reported (Saintilan and Williams 2000)

Location	Saltmarsh Loss	Period
Queensland		
BRISBANE-GOLD COAST area		
Oyster Point	75% (Saltpan)	1944-1983
Moreton Bay	65 hectares	1944-1988
Coolangatta-Caloundra	11%	1974-1987
NSW		
Tweed River	72%	1947-1986
SYDNEY area		
Weeney Bay,Botany Bay	100%	1950-1994
Woolaware Bay,Botany Bay	63%	1950-1994
Towra Point,Botany Bay	30%	1942-1997

What affects encroachment?

There are many and often interacting factors such as:

- Climate change (Co2, **Rainfall**, Sea Level)
- Human activities – modifying the environment
  - Direct impact on wetlands (e.g., filling)
  - **Land use/land cover** changes/effects of **population** change


Modifying environment
Indirect impact on the intertidal zone
Rainfall
What is the appropriate time frame?
Changing Climate
Runoff
How much, when, water quality?
Changing hydrology
CO2
Synergies with other factors: nutrients rainfall, sediment?
Sediment
How much, where?
Changing sediment
Intertidal wetlands
Synergies?
Changing Nutrients
Mangrove
Saltmarsh
Sea level
Short term effects?
Flooding patterns
Species composition, growth, colonisation
Direct impacts on the intertidal zone: urbanisation, industry, agriculture
Main drivers of change
Key variables affecting the intertidal zone.
? = important research questions
Interactions

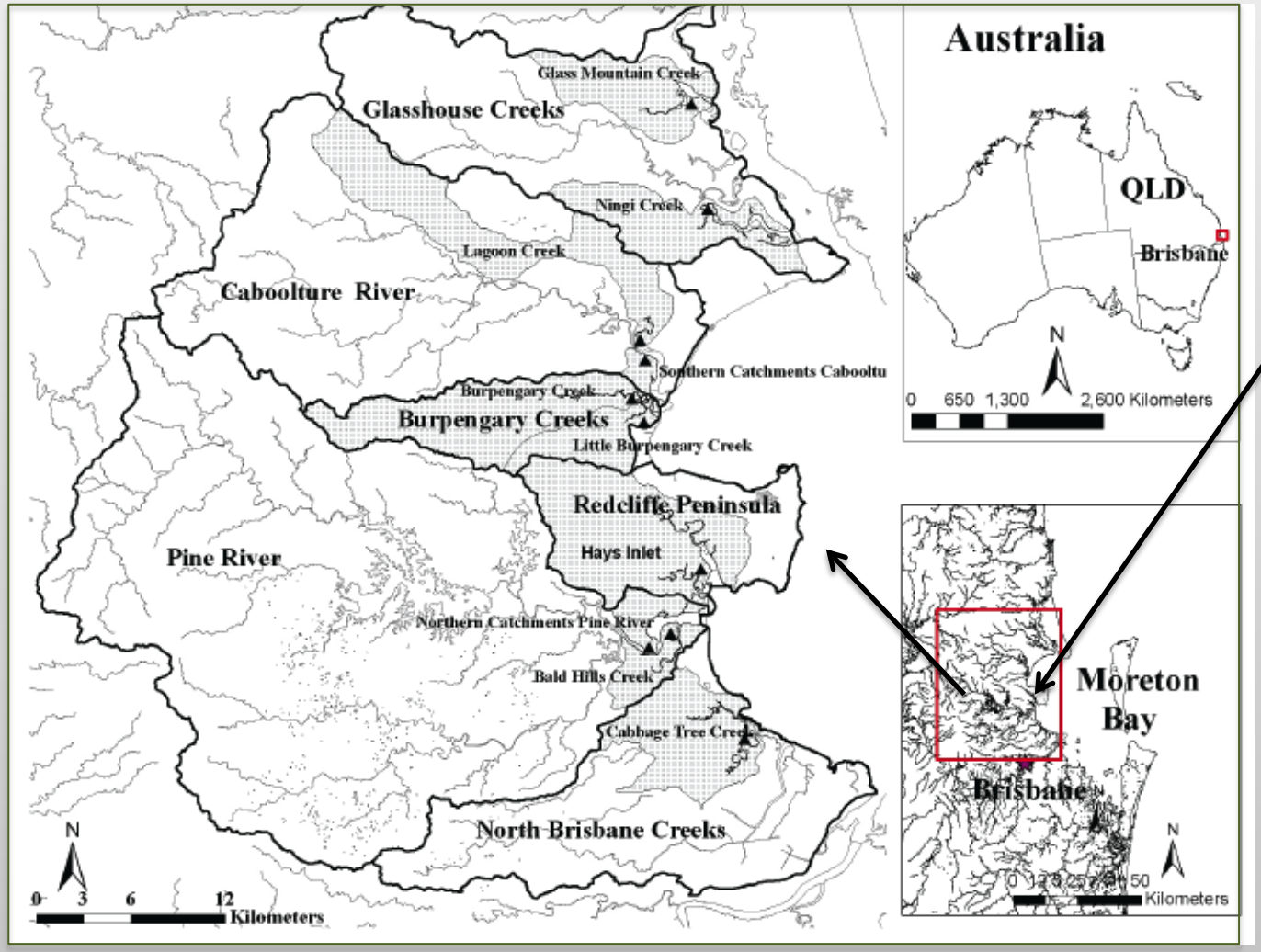
Research aim

To assess the relationship between mangrove encroachment into salt marsh and:

- Rainfall pattern;
- Land use/cover;
- Population changes; and
- MSI index (the proportion of mangrove forest adjoining salt marsh relative to boundary length)

Between 1972 and 2004 (1972 - earliest Landsat data)

Methods



Study sites: we selected 10 sites and their sub-catchments in northern Moreton Bay with similar climate.

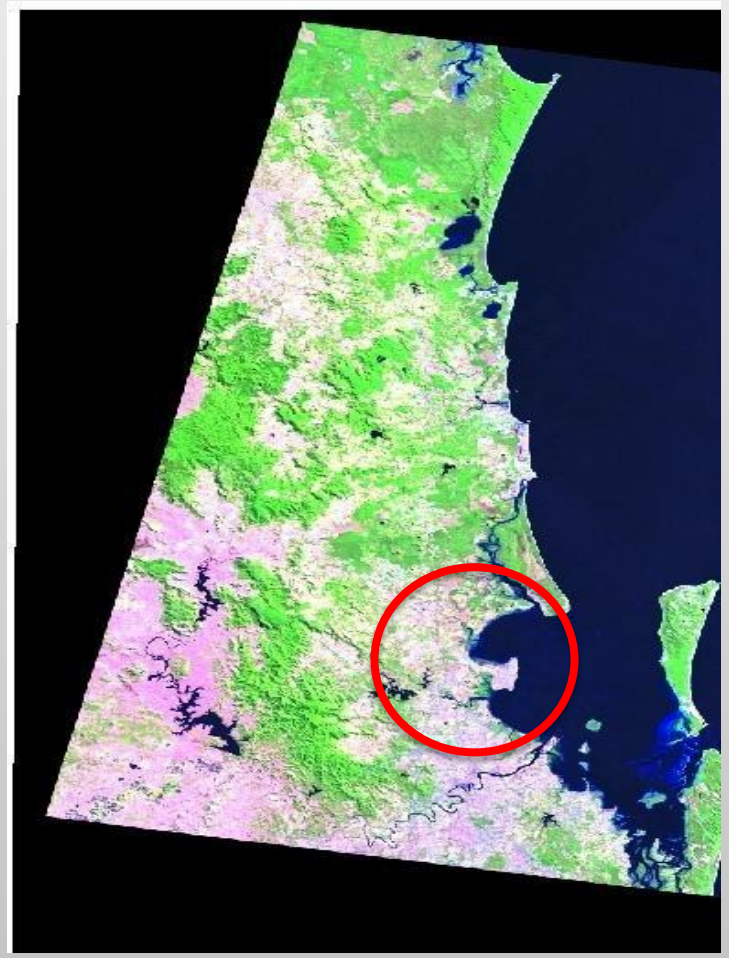
To the south is the densely populated State Capital, Brisbane; northwards population density is lower.

Data

- Published data
  - Daily rainfall data (Australian Bureau of Meteorology)
  - Population (Australian Bureau of Statistics)
- Remote sensing – Aerial photos and Landsat from 1972, 1990 and 2004 used to map:
  - Land use (**Landsat** classification - pixel 30m *)
  - Mangrove/salt marsh spatial patterns (**air photo** analysis at 1:24000 and 1:12000, scanned with 1000 and 500 dots per inch to produce digital images with a resolution of nearly 0.6 m per pixel)

* 1972 imagery at 80m pixel was resampled to a 30 m approximation

Landsat Satellite Imagery: Moreton Bay



Aerial photo mosaics for mangrove and salt marsh mapping

Analysis:1. identifying patterns

- Change analysis identified **1990** as a significant change point in **Rainfall pattern**: this was used to **define the time frame** for mangrove spatial analysis
- **Mangrove distribution** was mapped from air photo analysis for the **wet** (pre-1990) and **dry** period (post - 1990) for the study sites using ArcGIS
- The **Mangrove – Salt marsh Interface** (**MSI** index) was calculated (boundary length related to mangrove area)
- Change in mangrove distribution encroaching into saltmarsh was calculated as the annual increase % for each period *

Seaward expansion was also calculated but was relatively small

Analysis: 2. identifying relationships

Partial least square regression (PLSR) generalizes and combines features from **principal component** analysis and **multiple regression**

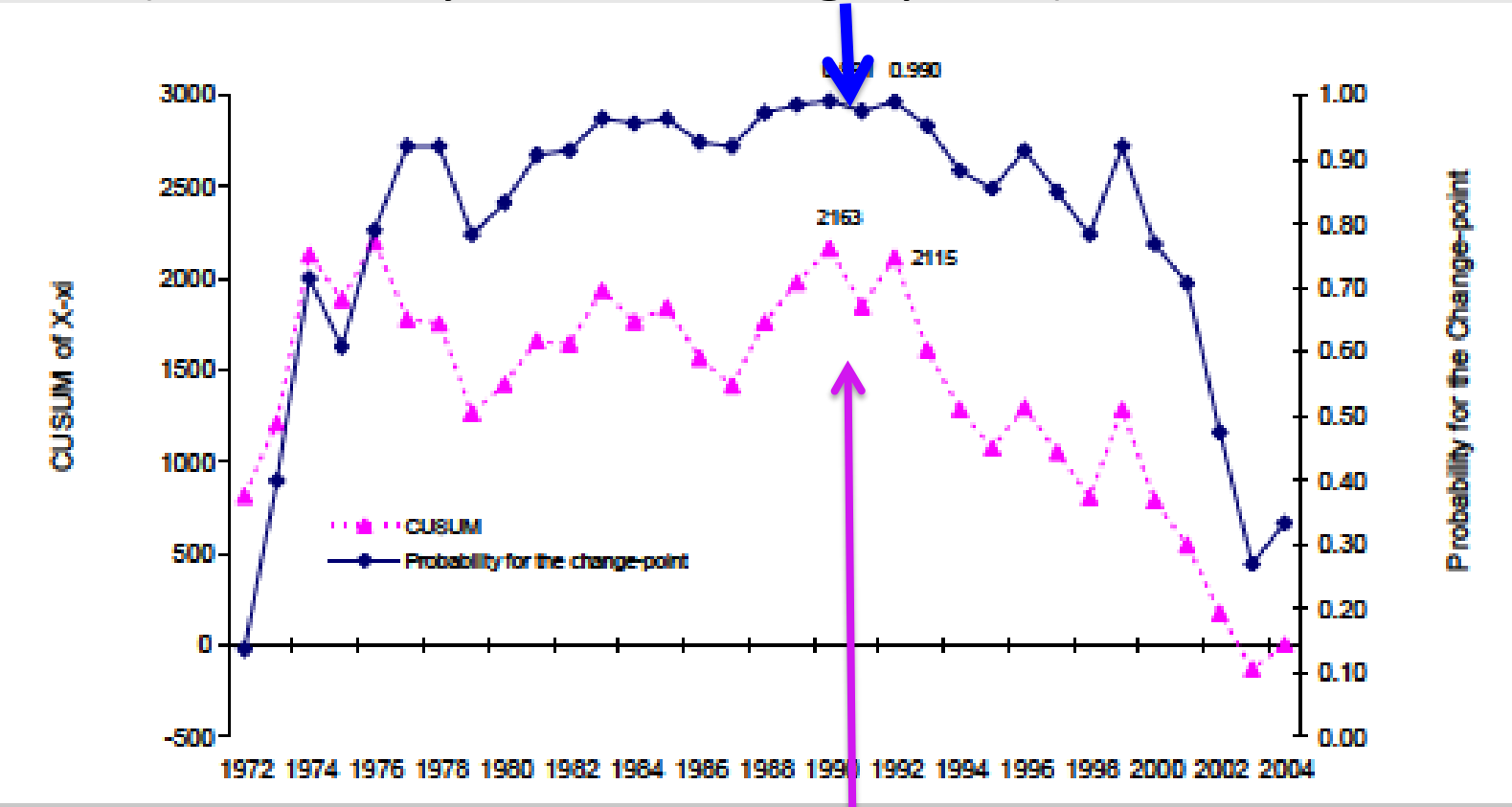
We used **PLSR** to analyse and identify the relation between **the rate** of mangrove expansion and **rainfall, land use** and **population density** and its **potential expansion** (represented by the **MSI index***),

during the wet (pre-1990) and the dry (post-1990) periods.

*** The Mangrove – Saltmarsh – Interface index**

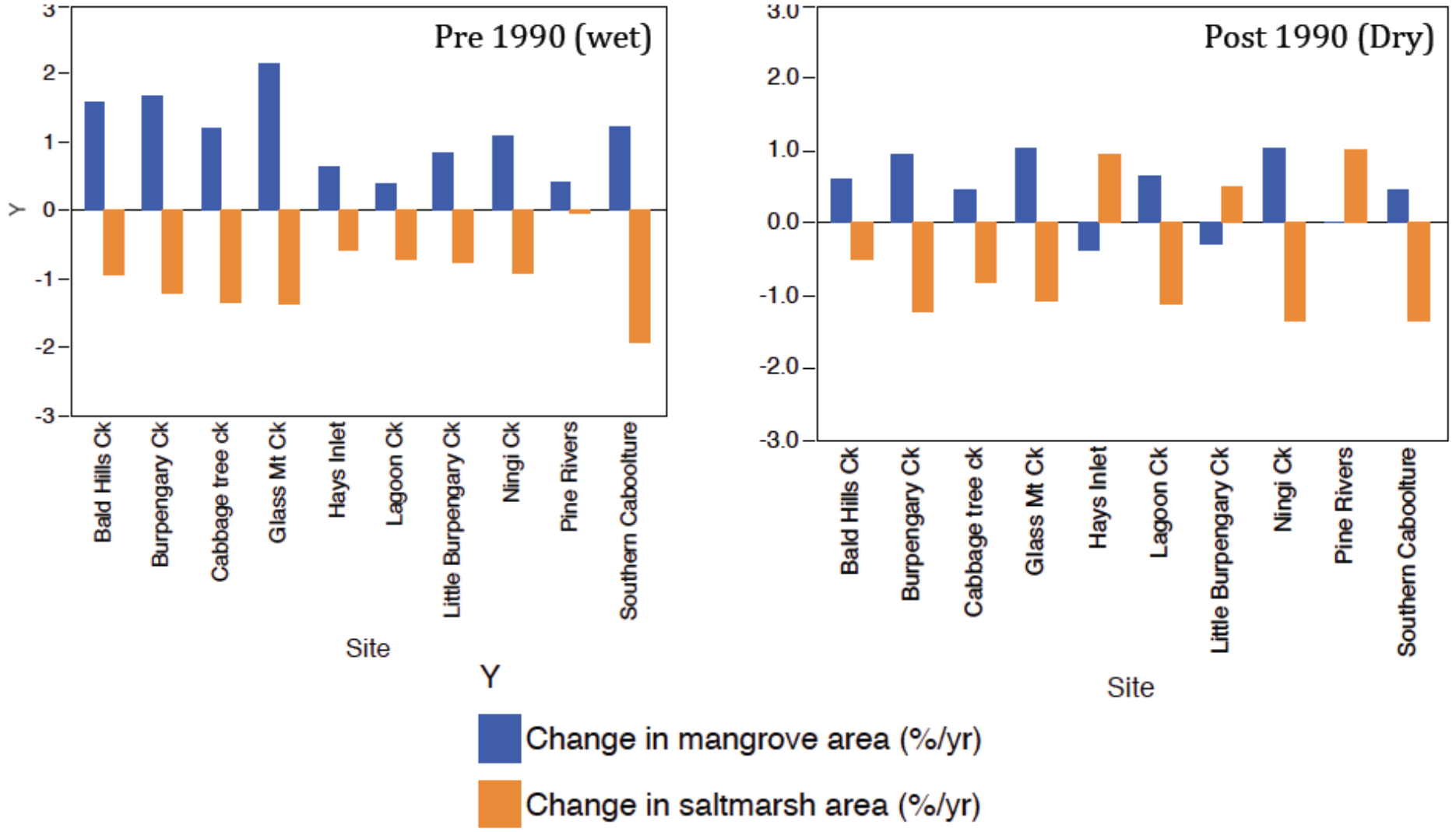
Results

- Rainfall change point in 1990: Pettit-Mann-Whitney test (Probability of the change point)



The‘cumulative sum technique’ (CUSUM) which detects changes in the mean value of a time series dataset,

Mangrove/saltmarsh rate of change: summary by site



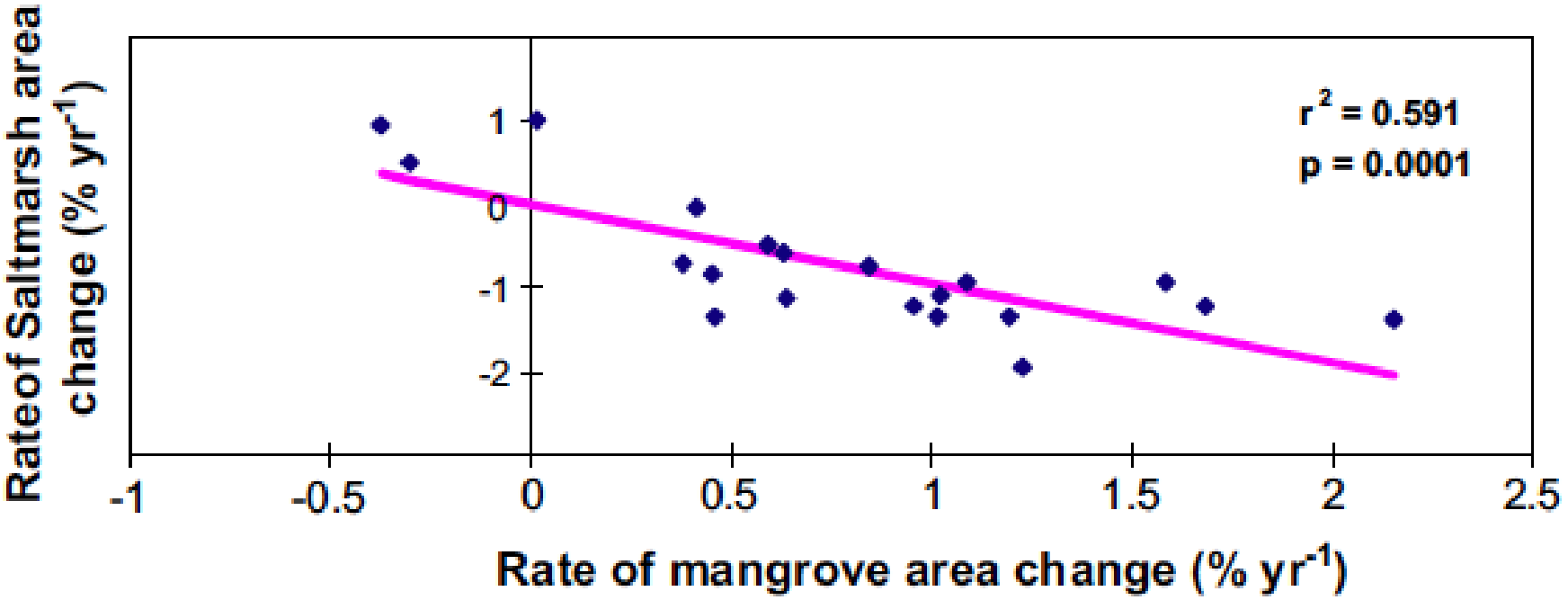
Site	Mangrove area change between 1972 and 2004 (ha)
Cabbage Tree Ck (S area)	13.4
Bald Hills Ck	21.48
Pine Rivers	5.06
Hays Inlet	8.31
Little Burpengary Ck	6.68
Burpengary Ck	6.47
Southern Caboolture	20.37
Lagoon Ck	6.16
Ningi Ck	9.46
Glass Mt Ck (N area)	21.76
TOTAL 10 sites	**119.11**

How much increase in mangrove area?

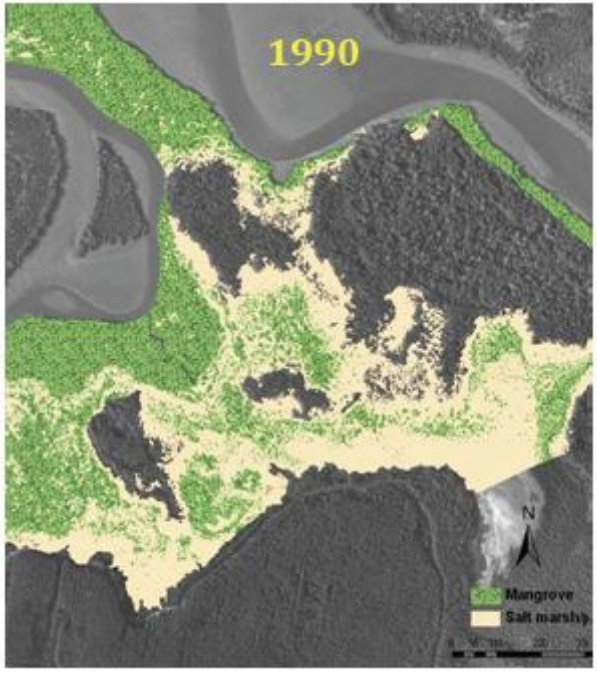
Over the same period 117 ha of salt marsh has been lost

So far we have not seen any loss at the seaward edge – will sea level rise change this? Over what time frame?

Mangrove increase /salt marsh decrease



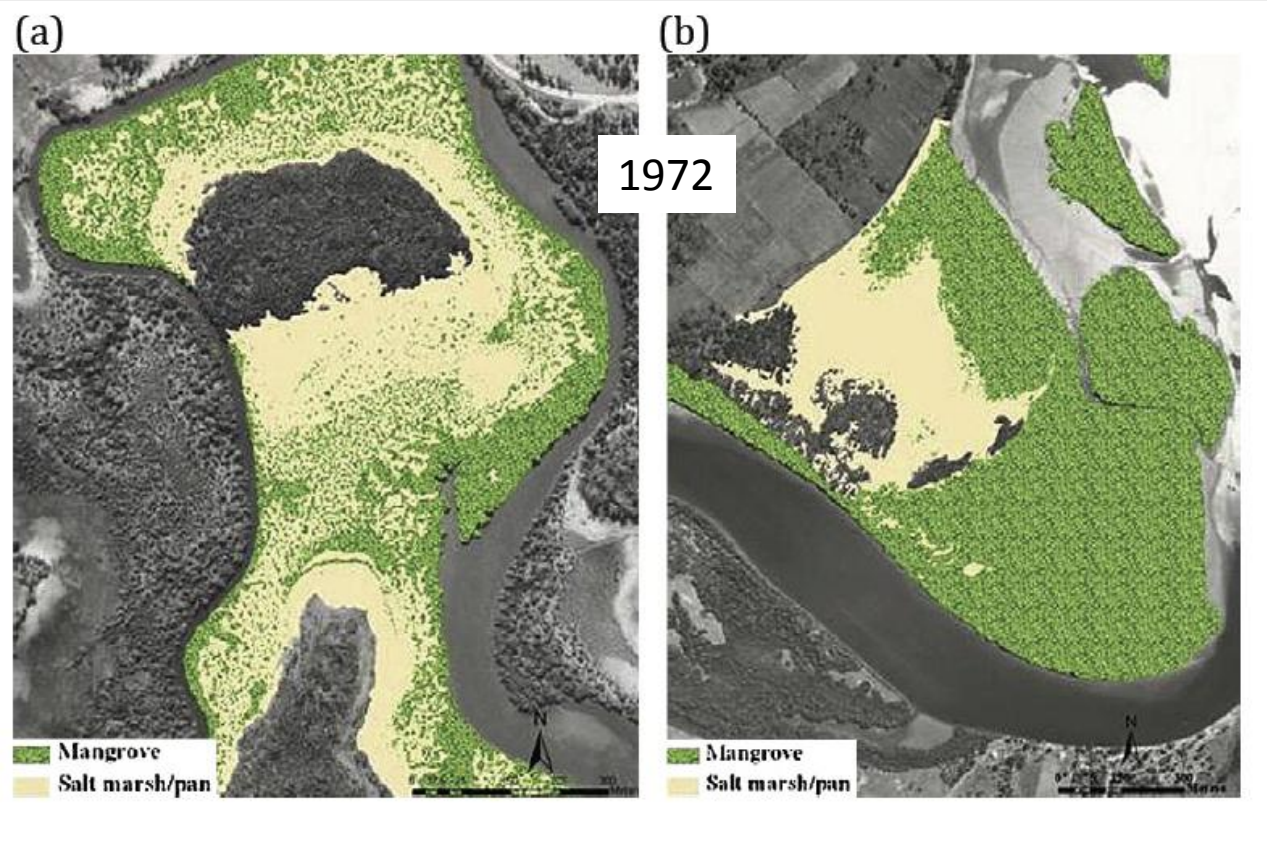
Mangrove spatial change example: Glass Mt Creek



Pre 1990 mangrove change = 2.15%/yr

Post 1990 mangrove change= 1.02%/yr

Boundaries matter- the opportunity for expansion – Mangrove Saltmarsh Interface index (MSI)



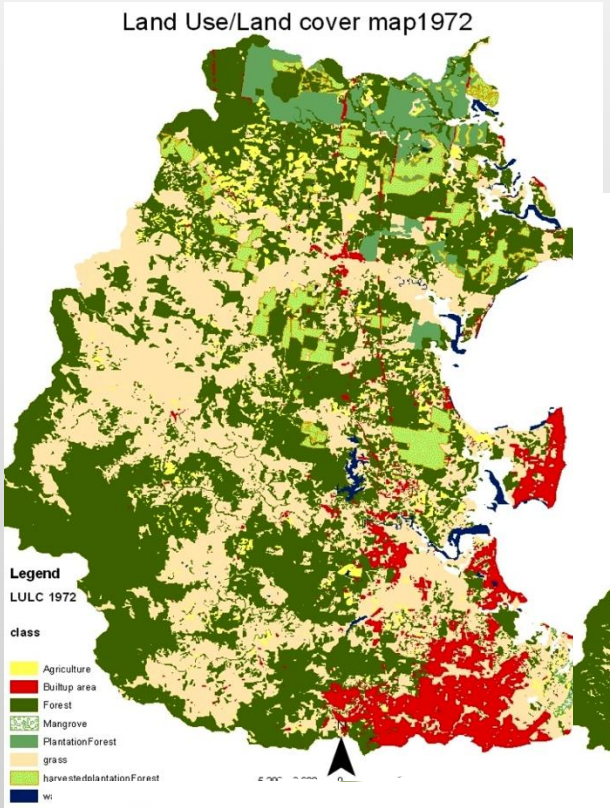
MSI is based on the ratio between the length of boundary and mangrove area: a **large MSI** index indicates a **long boundary** and hence **opportunity for expansion**. A small index is the reverse.

(a) Scattered patches at Ningi Creek with **large MSI** 1972 (15.76); rate of expansion pre 1990 = **1.09%/yr**

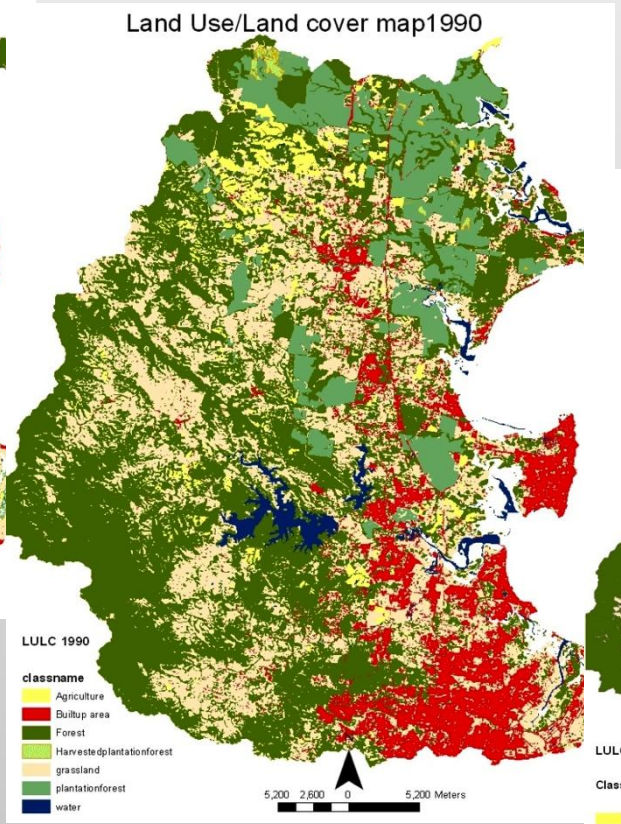
(b) Aggregated cover at Pine River with **small MSI** 1972 (0.75); rate of expansion pre 1990 = **0.41%/yr**

Land cover/use change

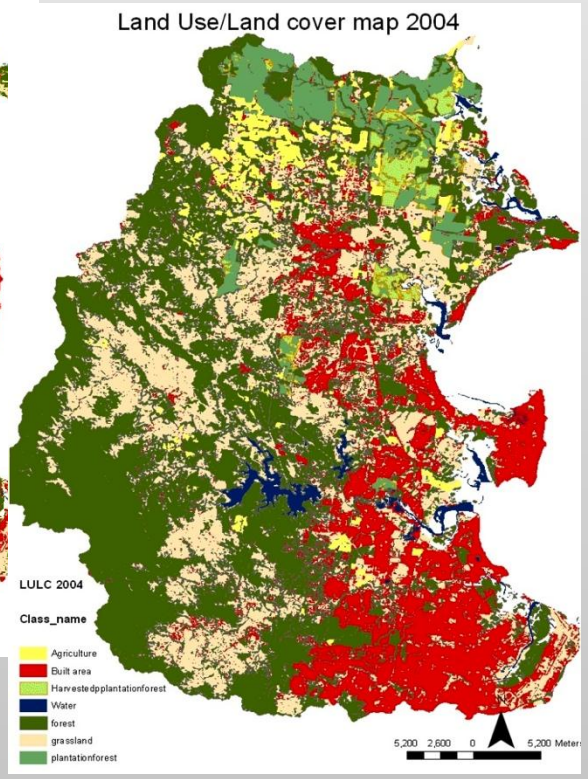
1972



1990



2004



Mangrove expansion PLSR analysis: wet and dry periods compared

The PLSR results of Components 1and 2 (Comp)

Variable	**Mangrove expansion rate pre-1990**		**Mangrove expansion rate post-1990**	
	Comp1	Comp2	Comp1	Comp2
Rainfall median	**0.491**	-0.126	**0.543**	0.100
MSI index	**0.709**	0.011	**0.646**	0.406
Population density	0.082	**0.620**	-0.160	**0.693**
Agriculture (%)	**-0.541**	-0.431	0.081	-0.433
Built up (%)	-0.127	0.548	-0.300	0.427
Plantation forest (%)	0.431	-0.373	0.515	-0.083
Variance x-block	0.385	0.385	0.618	0.187
R^2	0.759	0.154	0.561	0.171
P-value	0.001	0.005	0.012	0.053

PLSR weights whose squares are larger than 0.2 are shown in bold type, as they retain relatively high information content of each component.

Conclusion

- The research established a significant relationship between rainfall pattern and the landward expansion of mangroves in Moreton Bay's subtropical estuaries;

- A key finding of this research was that the contribution of landscape variables to spatial changes in the mangroves changed following a reduction in rainfall

  - During wet periods mangrove expansion was related to sub-catchment-wide land use/cover pattern and population density

  - During drier periods it was more affected by local effects of nearby land use/cover (within 500m)


Thank you