Asia-Pacific Climate Change Adaptation Forum 2013
18-20 March 2013, Incheon, Republic of Korea

Adapting coastal settlements to climatic futures: some ideas from Australia

Marcello Sano

Griffith University, Australia

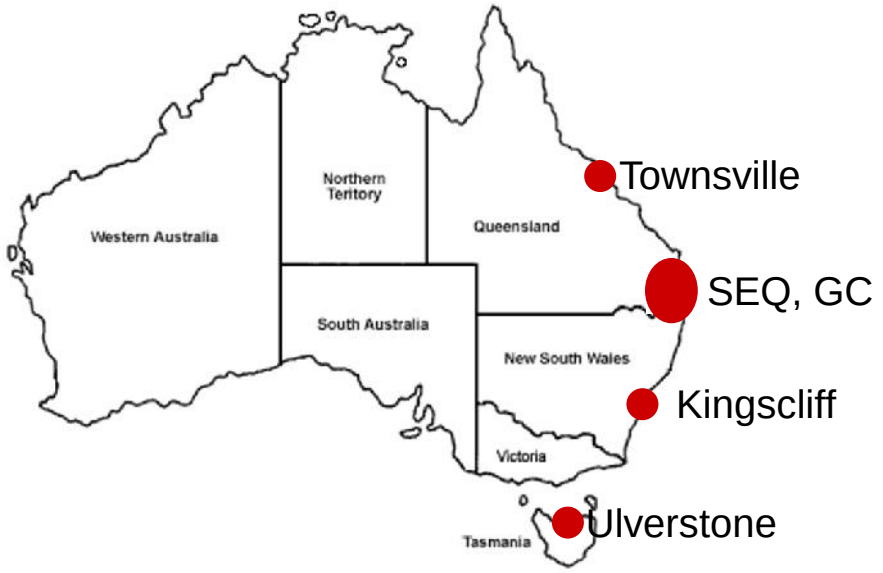
Outline

Climate **Variability** vs Climate **Change**

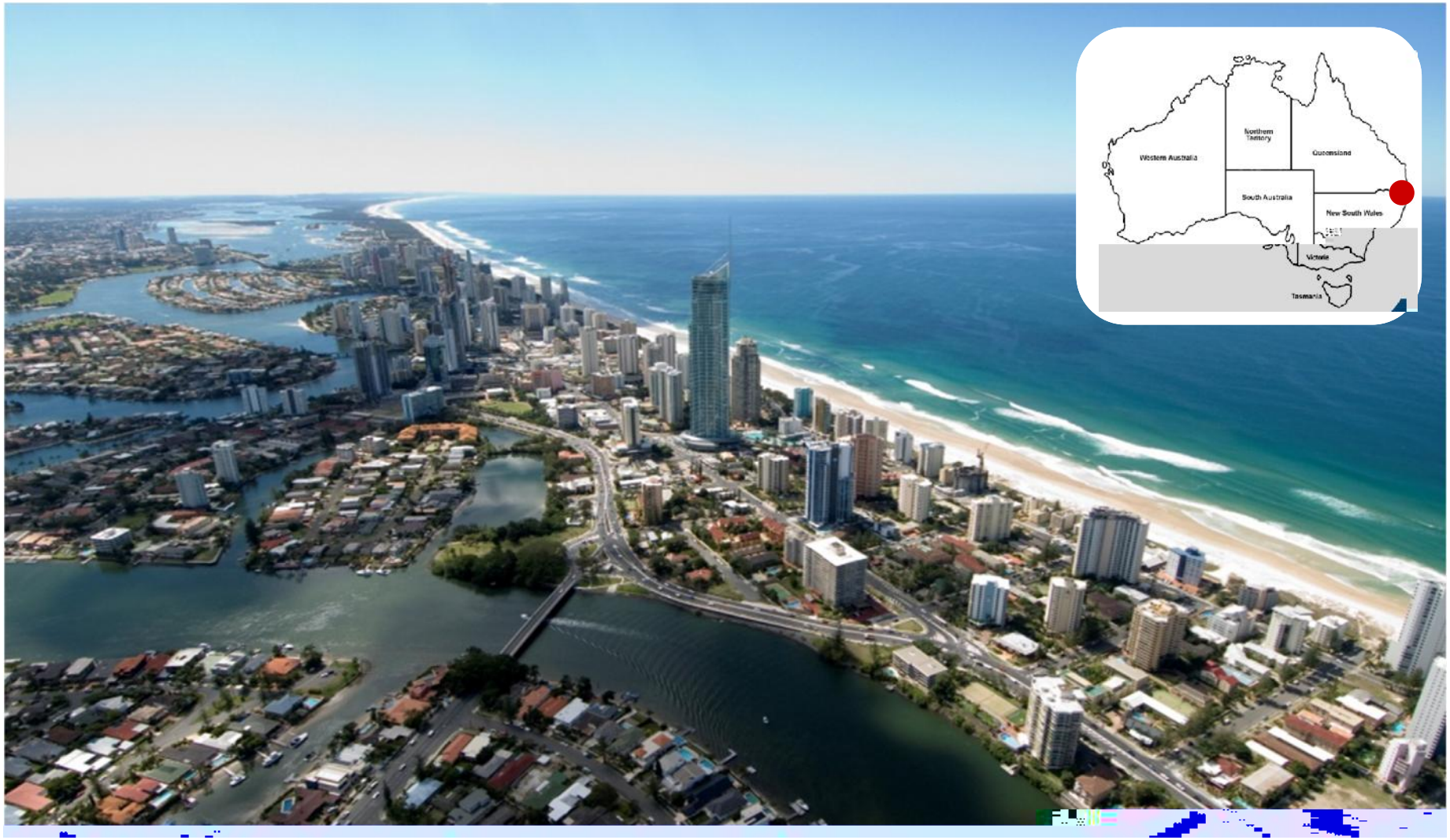
Vulnerability of human settlements

Planning for **adaptation**:

- » Systems thinking and modeling
- » Scenario planning
- » Mainstreaming adaptation in policies
- » Local scale applications



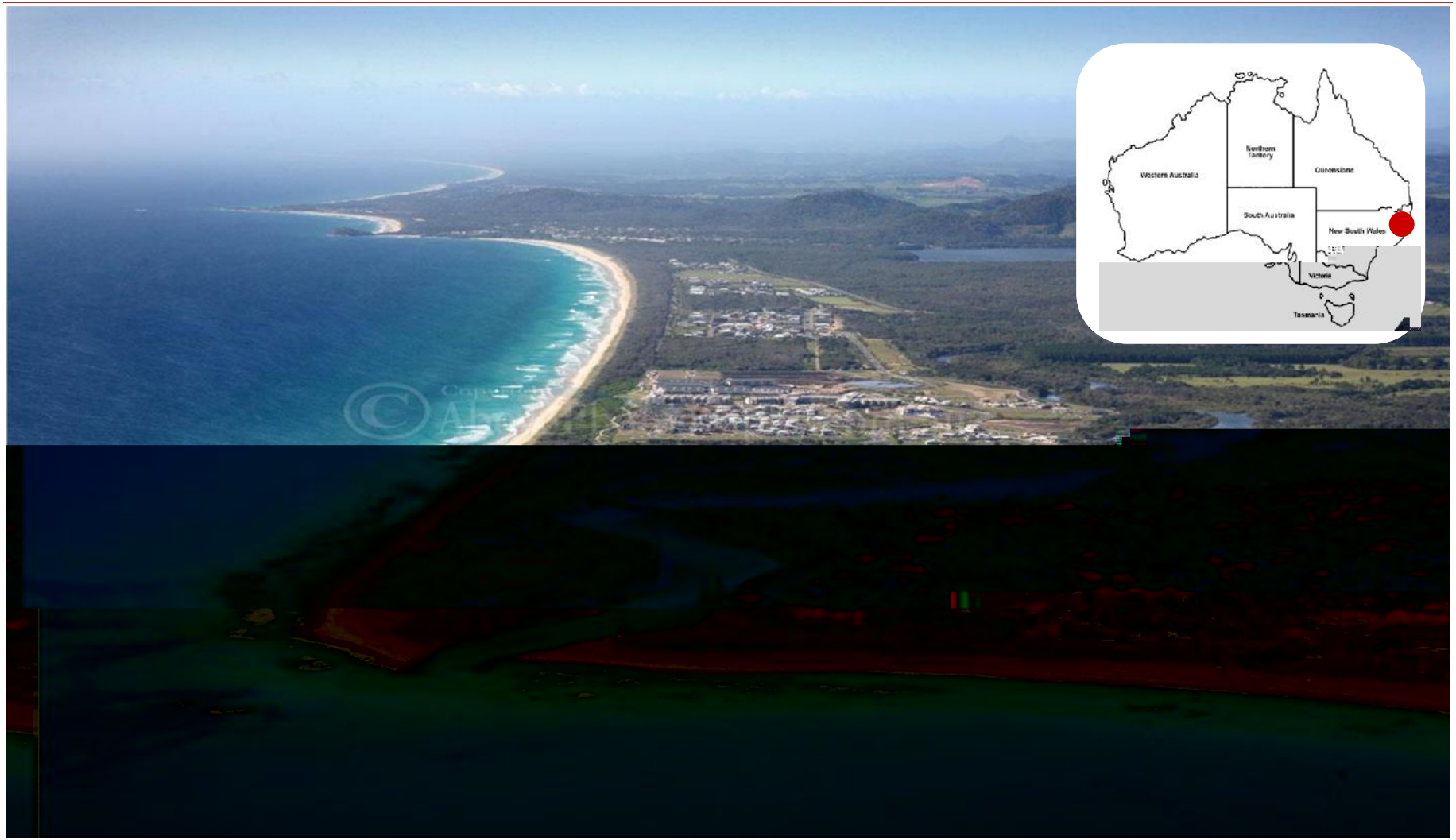
Gold Coast


Western Australia
Northern Territory
Queensland
South Australia
New South Wales
Victoria
Tasmania

Townsville


Western Australia
Northern Territory
Queensland
South Australia
New South Wales
Victoria
Tasmania

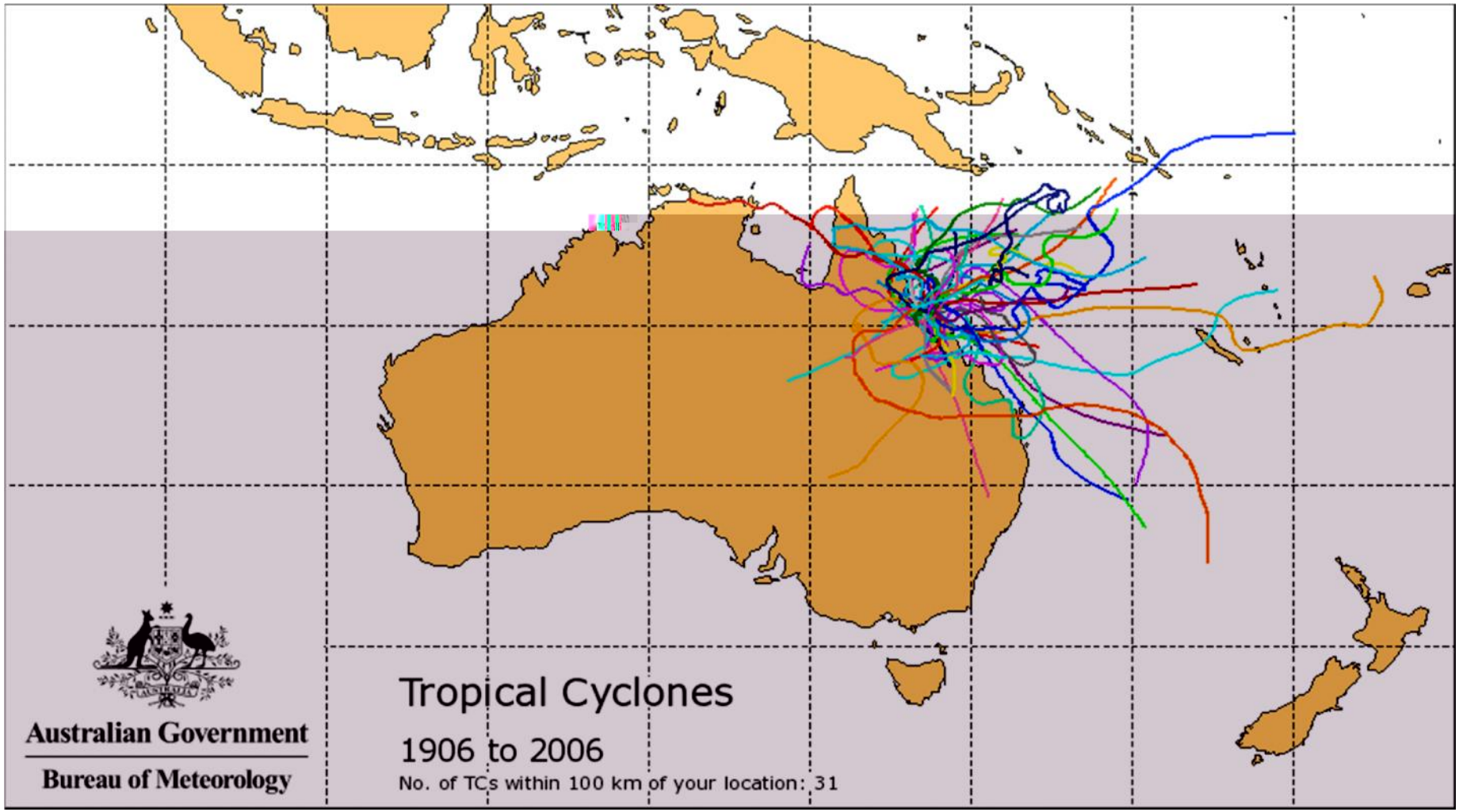
Kingscliff, NSW



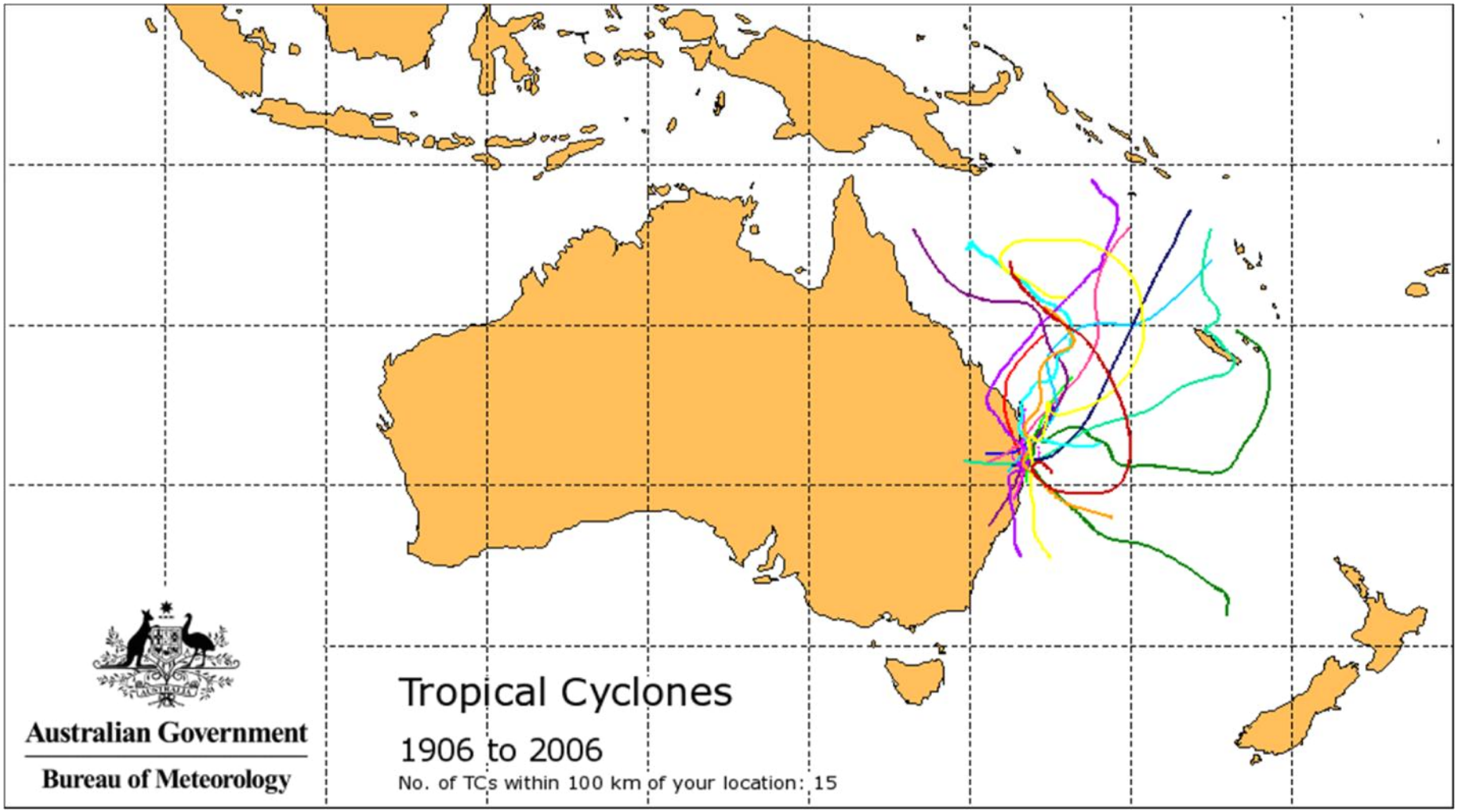
Ulverstone, TAS

CLIMATE VARIABILITY AND CHANGE

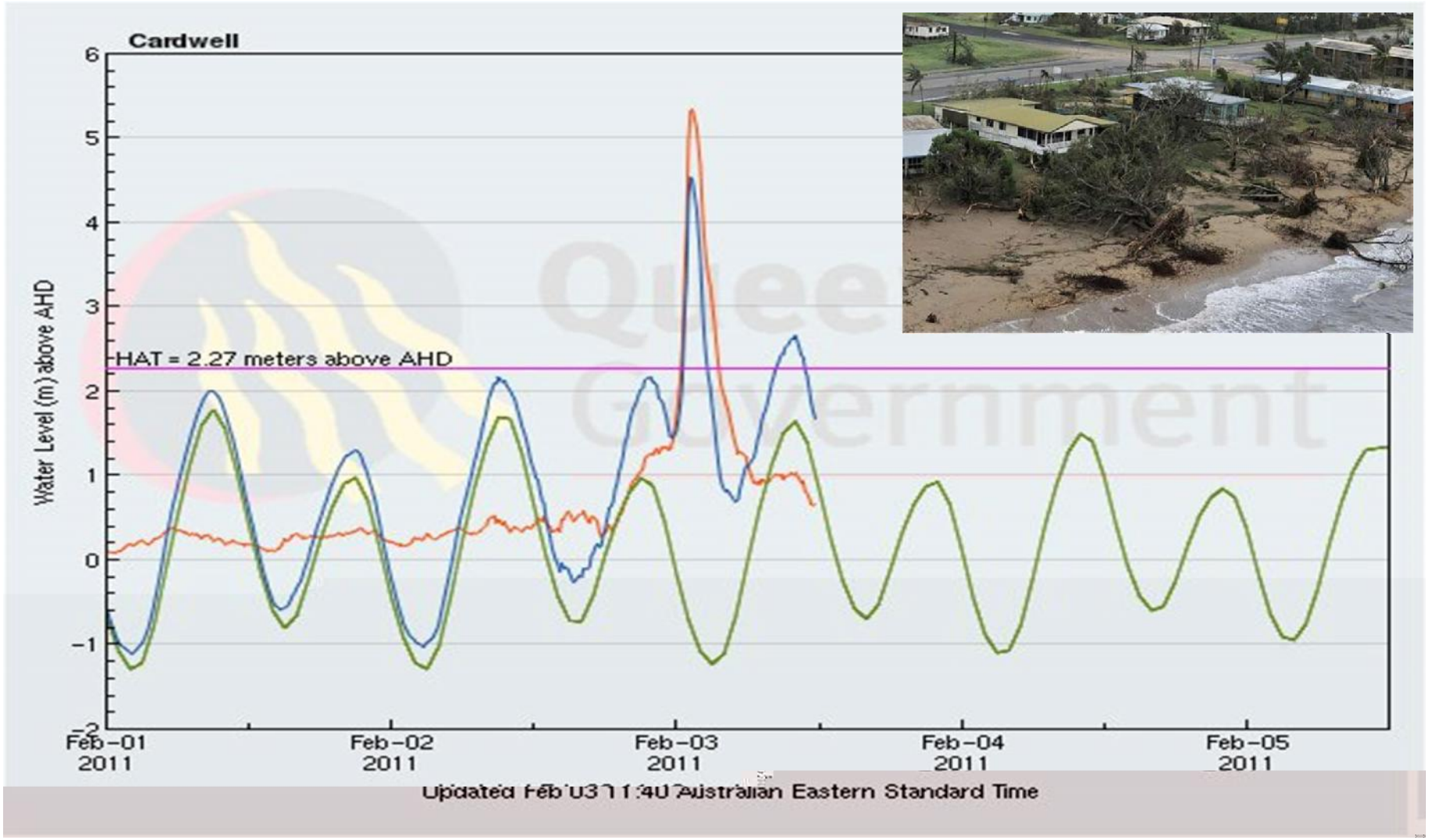
Climate variability



Climate variability



Cyclone Yasi, 2011



Climate variability - 1967

Jan – May 1967:
5 TCs

+

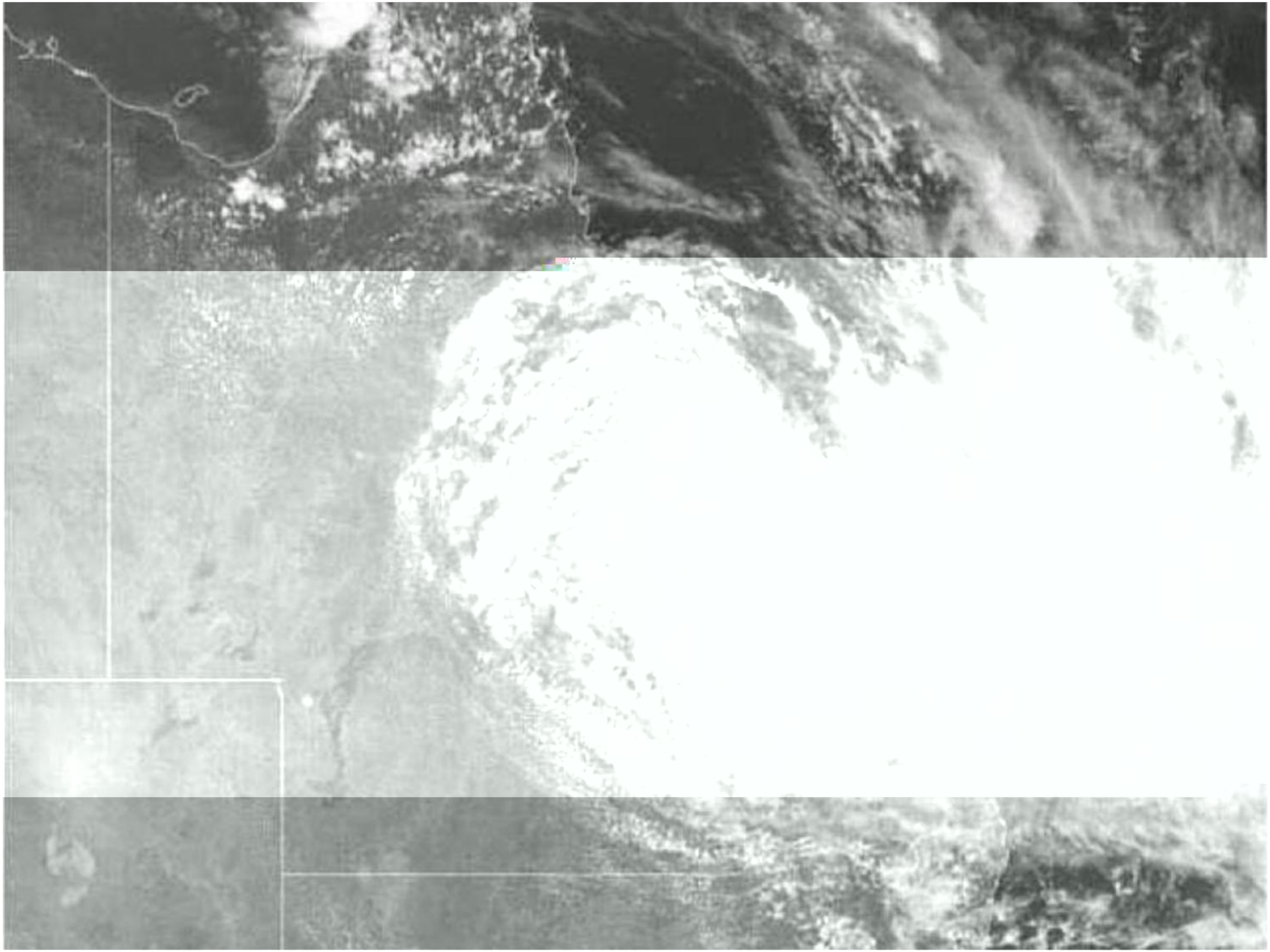
June 1967:
3 East Coast Lows

=

8M m^3 of sand eroded from the Gold Coast beaches

Climate variability - Kingscliff

2007 **2010**



Oswald, January 2013


DANGER

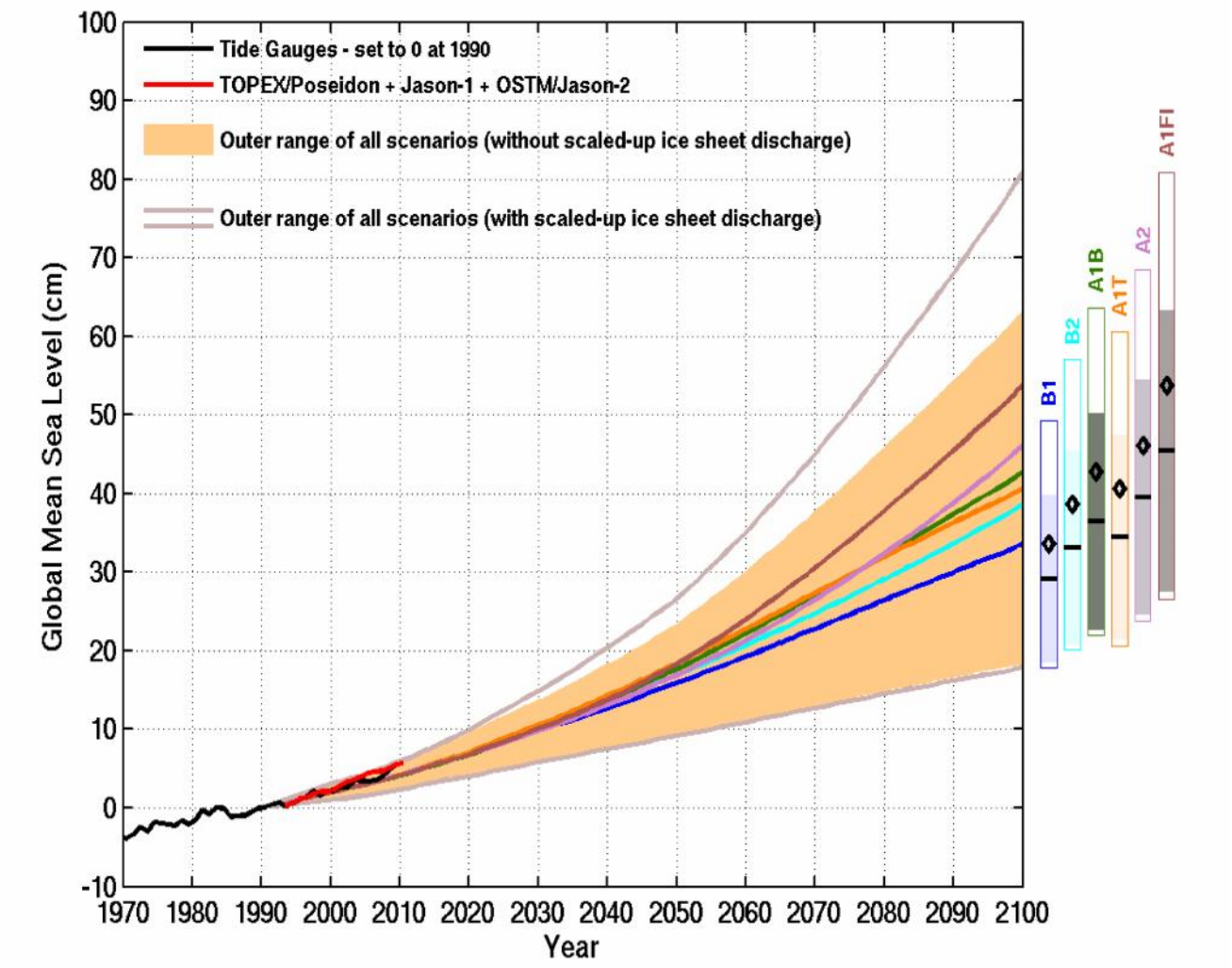
Sea level rise observations

Net relative sea level trend

after subtracting the effects of the vertical movement of the platform and the inverse barometric pressure effect utilising data from 1992 to 2011 (Australian Bureau of Meteorology 2011)

Future trends

- **Sea level rise**: ~0.5 to 1.5 m by 2100 (CSIRO)
- **Wave climate**: under investigation
- **Changing cyclones**: under investigation

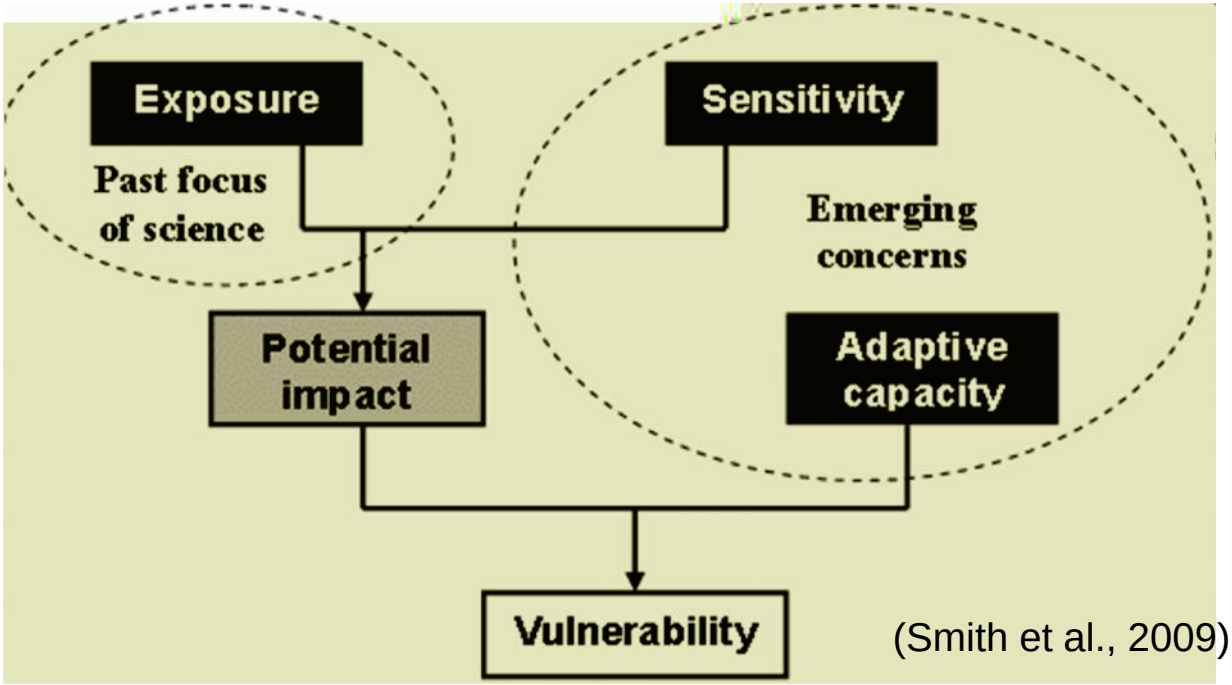


VULNERABILITY OF HUMAN SETTLEMENTS

Vulnerability framework

IPCC AR4:

Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is **exposed**, its **sensitivity**, and its **adaptive capacity**).



(Smith et al., 2009)

Vulnerability hotspots

Coastal Vulnerability Index:

$$CVI_j = \frac{\left[E_j \times \left(\sum_{i=1}^{n} C_{ij}\right)\right]}{n+1}$$

(adapted from Langlois, 2001)

Where:

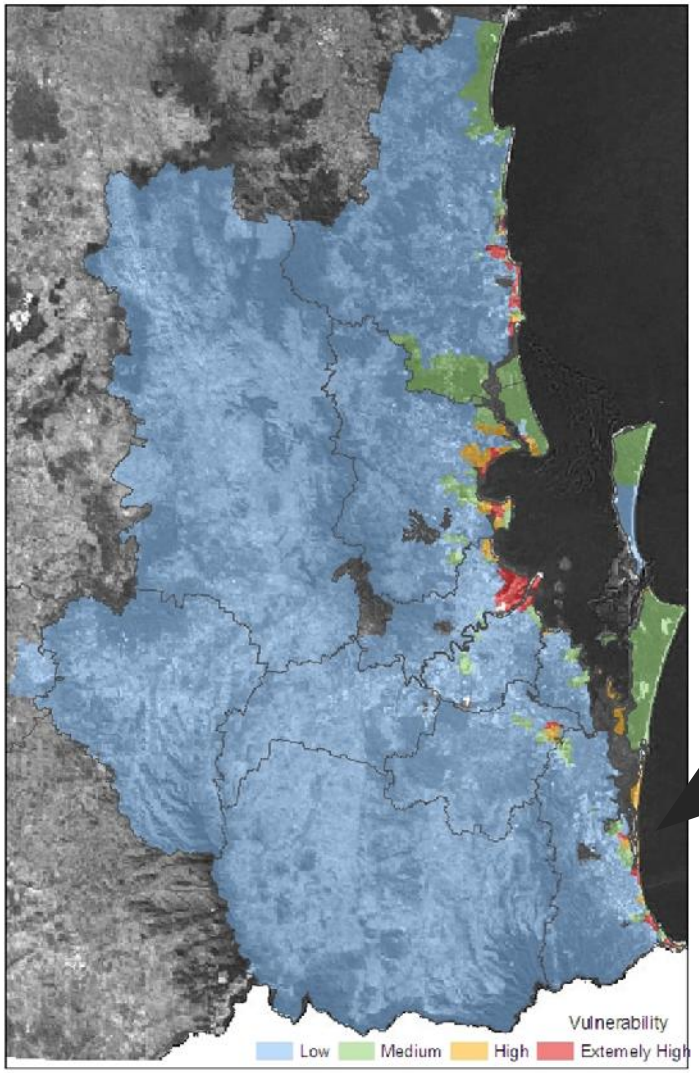
E_i is the proportion of the suburb within a Coastal Hazard Area as defined by the Queensland Coastal Plan

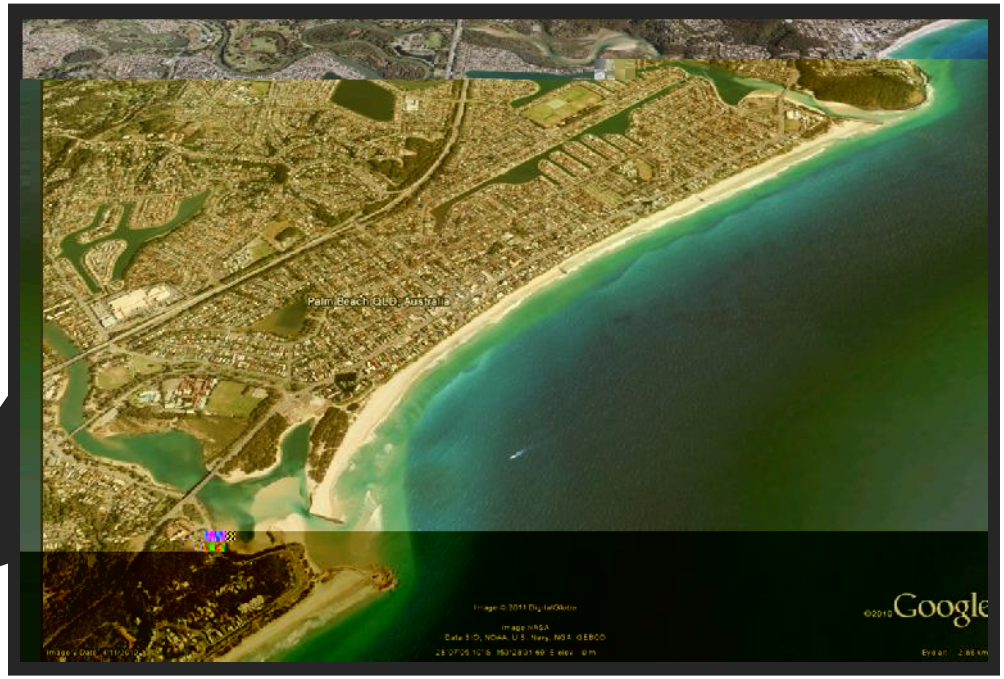
C_{ij} is the standardised score for component i for suburb j* after PCA

*Considering the structure of the available datasets, including both descriptors of socio-economic sensitivity and adaptive capacity, these are considered together for PCA

Australian Bureau of Statistics data used in PCA
% of population older than 64 years of age
% of population who live alone
% of population less than 5 years of age
% population completing year 12
% households with internet access
Medium household income
Labour force participation rate
Average household size
% of single parent families
% of public housing
% of households who are outright owners
Unemployment rate
% of people who need assistance
% of people living at the same address as 1 year ago
% population doing voluntary work
% of people who are not Australian citizens
% of people born overseas
% of recent arrivals (arrived in Australia between 2001 and 2006)
% of people with poor English skills

Vulnerability hotspots

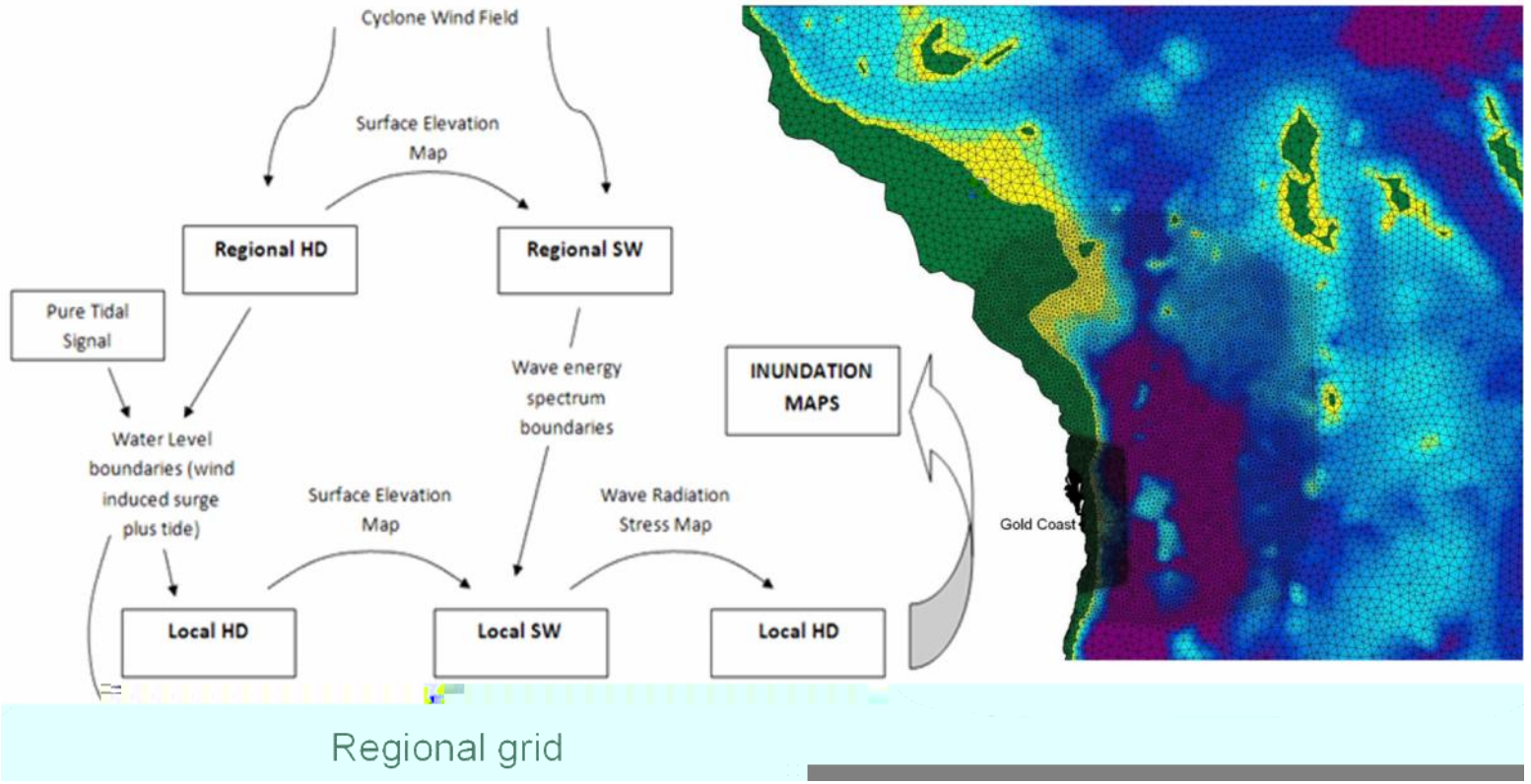


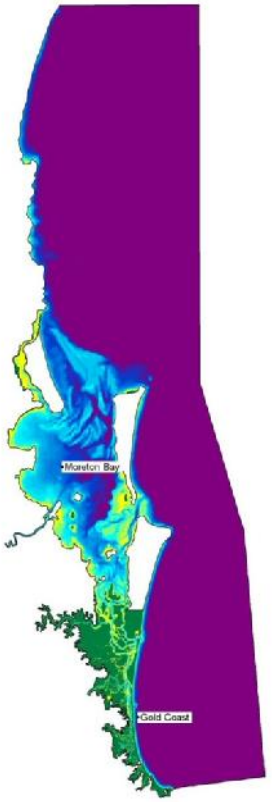


Palm Beach, Gold Coast

Detailed assessment – Palm Beach

MIKE 21 Hydrodynamic simulation with two sea level scenarios: 0,5 m (2050) and 1 m (2100)



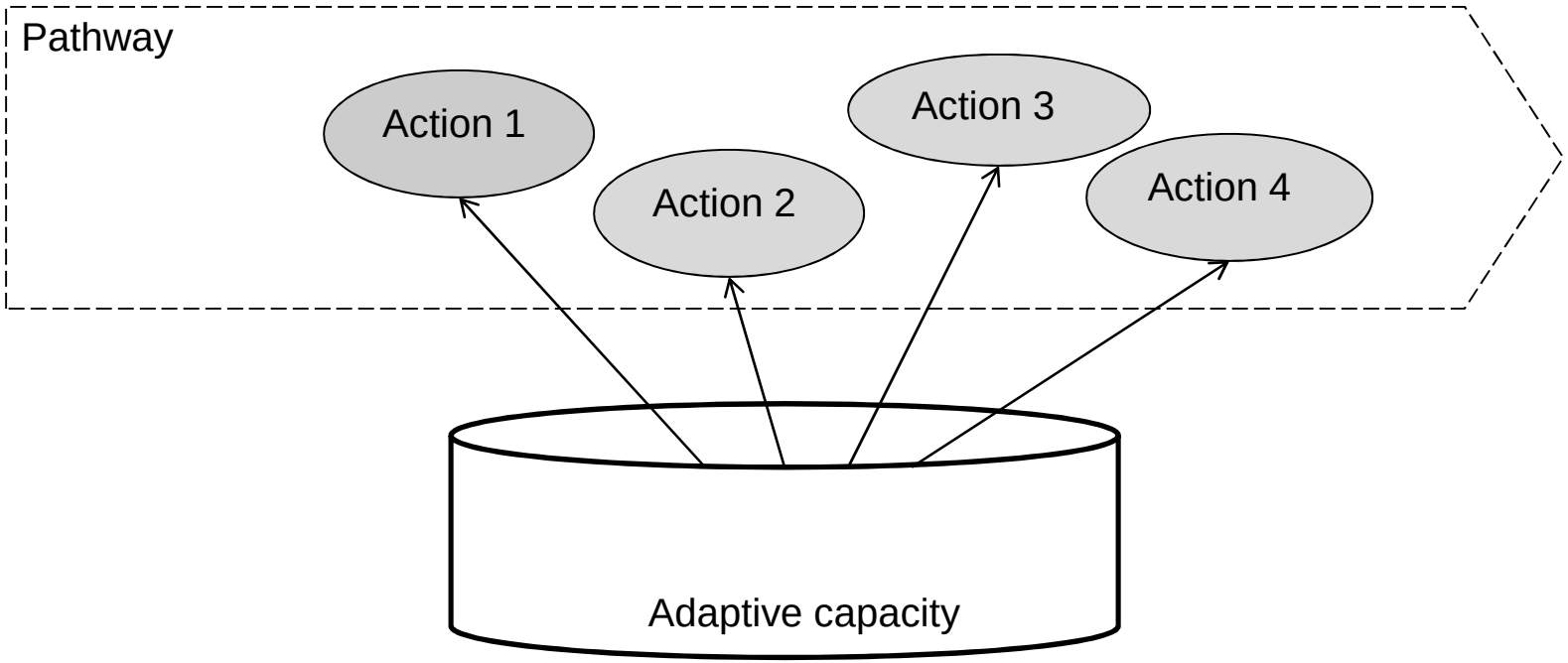


Local grid

PLANNING FOR ADAPTATION

Concepts

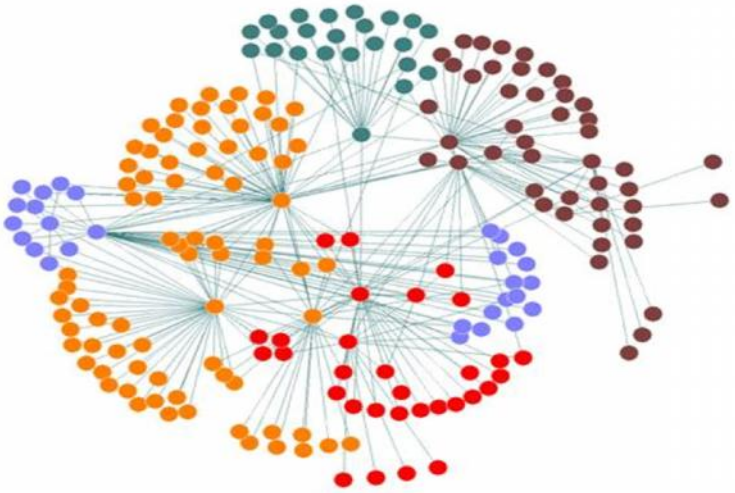
- **Adaptation pathway**: a broad course determining adaptation policies
- **Adaptation action**: a specific alternative option within a pathway
- **Adaptive capacity**: the ability to implement adapation actions



Tools

- **Systems Thinking** and **Modelling** approach:

- Social Network Analysis
- System conceptualization with stakeholders
- Structural analysis (influence, MICMAC, R)
- System Dynamics
- Bayesian Belief Modelling



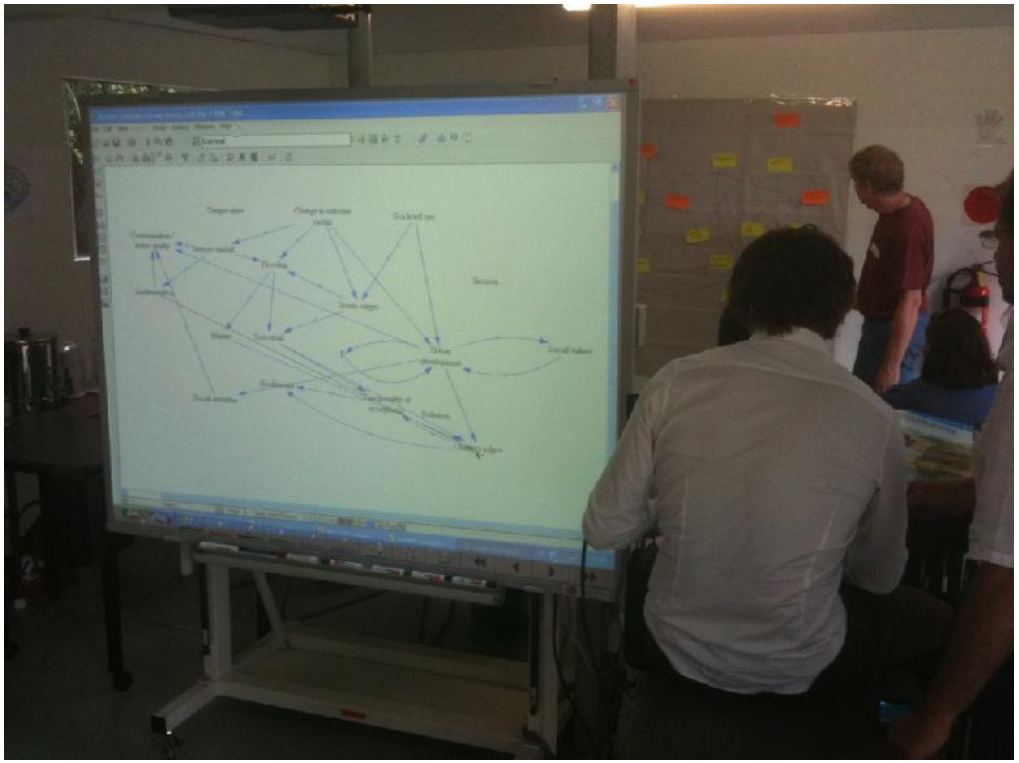
Exploring adaptation pathways

Systems thinking approach:

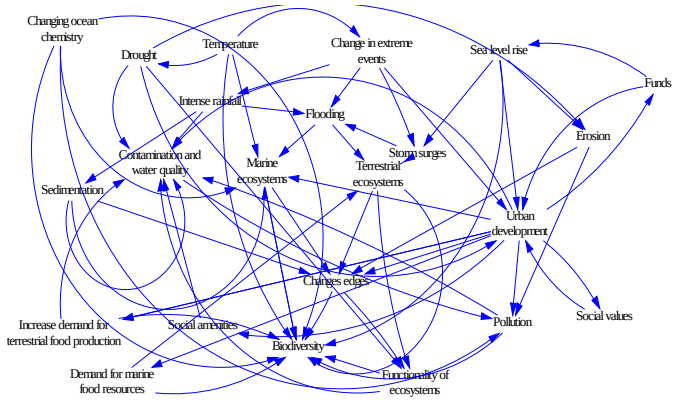
D: Climatic and socio-economic **Drivers**

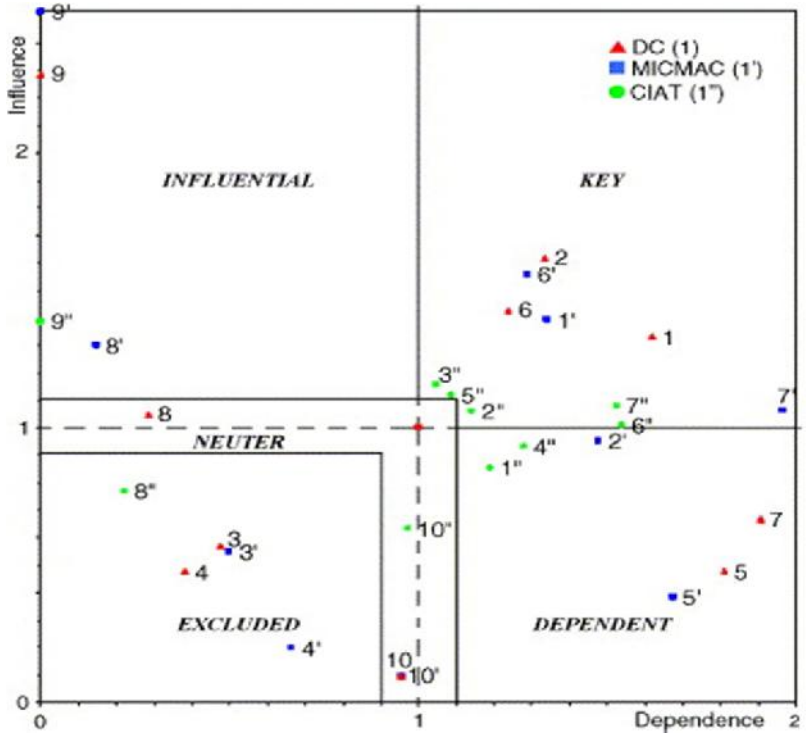
I: **Impacts** on the coastal system

R: Possible Adaptive **Responses**



Exploring adaptation pathways



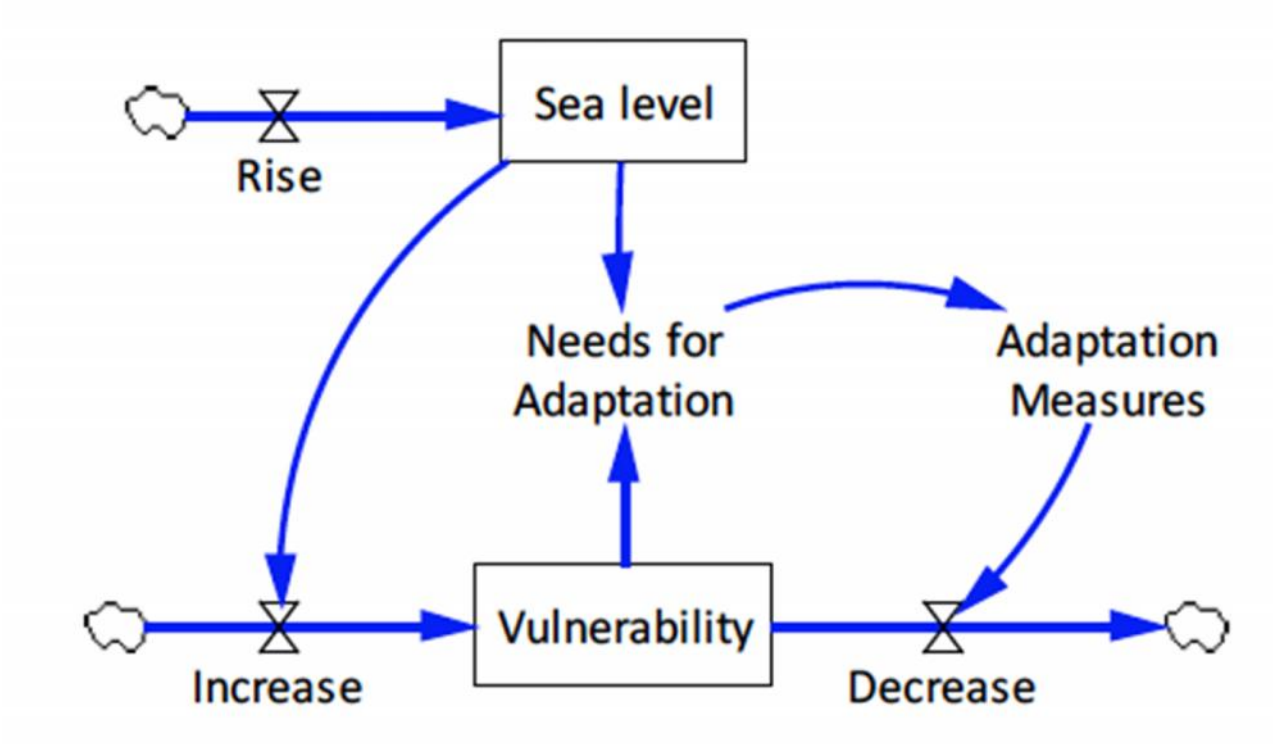


Systems structural analysis (INFLUENCE, MICMAC):

Identification and classification of critical pathways and adaptive responses

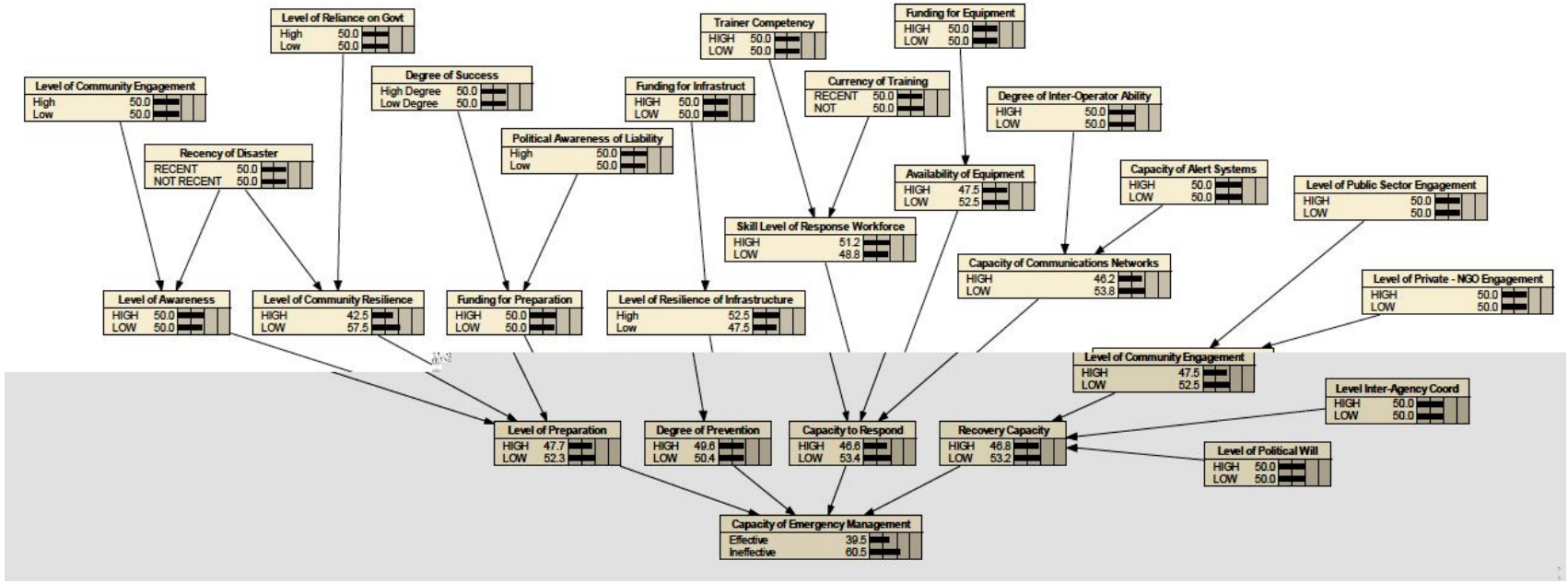
System dynamics simulations

Modelling behaviour over time of the system

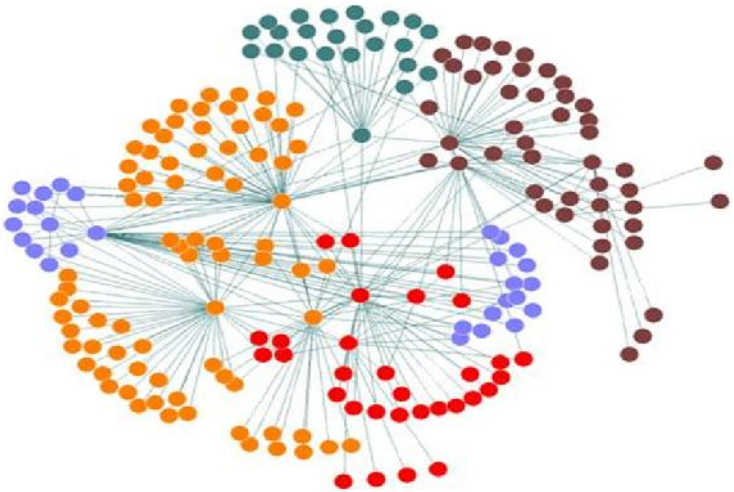


Bayesian Modelling

Assessing the **adaptive capacity** to **implement options**

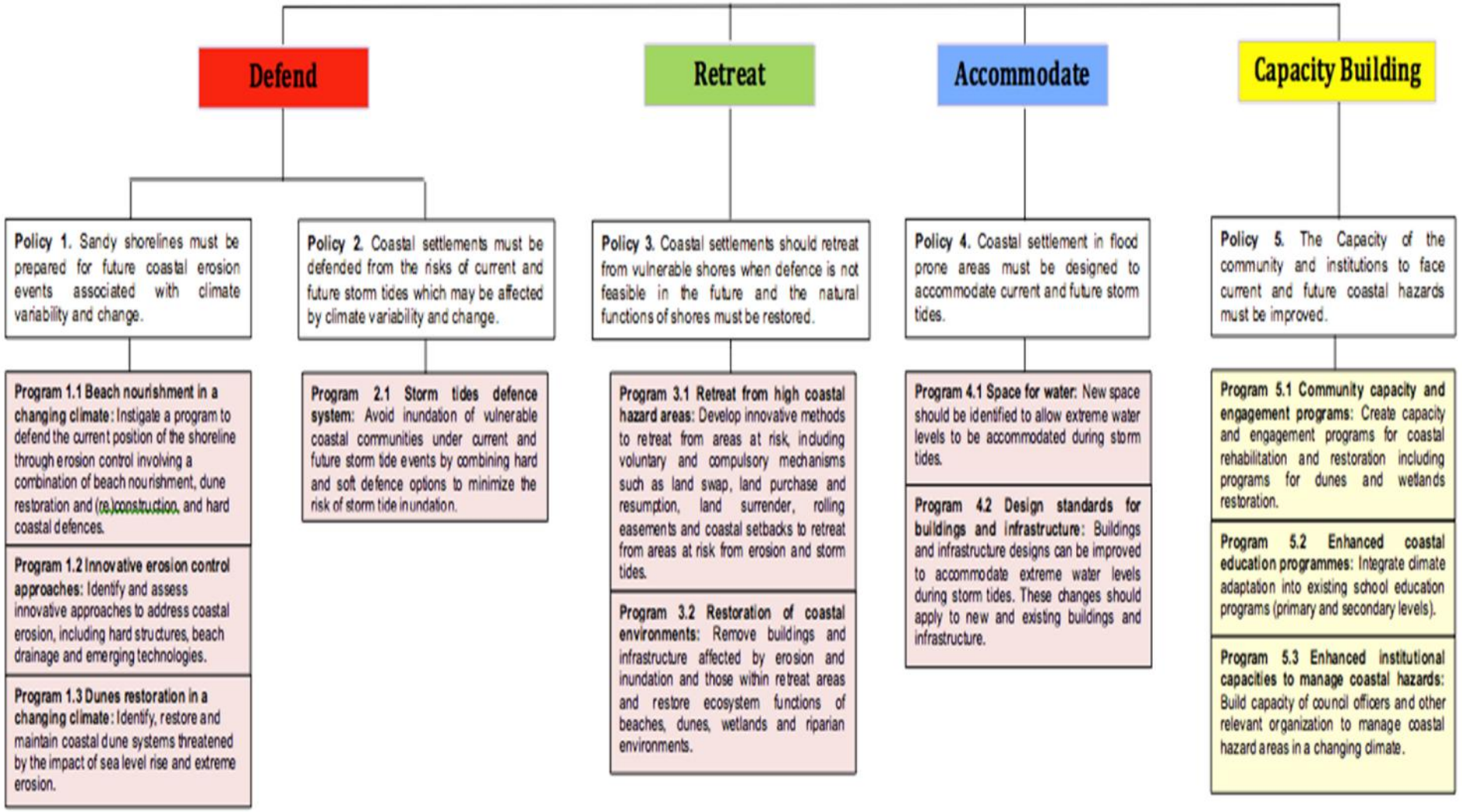


Adaptation pathways



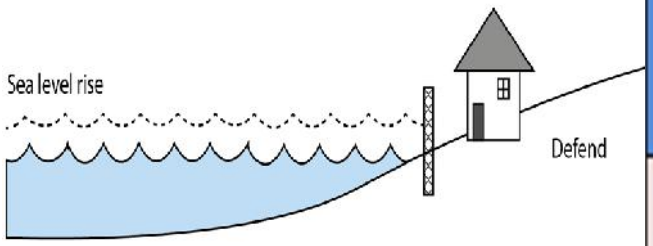
Policies,
Programs,
Actions

Framework


Defend
Retreat
Accommodate
Capacity Building
Policy 1. Sandy shorelines must be prepared for future coastal erosion events associated with climate variability and change.
Policy 2. Coastal settlements must be defended from the risks of current and future storm tides which may be affected by climate variability and change.
Policy 3. Coastal settlements should retreat from vulnerable shores when defence is not feasible in the future and the natural functions of shores must be restored.
Policy 4. Coastal settlement in flood prone areas must be designed to accommodate current and future storm tides.
Policy 5. The Capacity of the community and institutions to face current and future coastal hazards must be improved.
Program 1.1 Beach nourishment in a changing climate: Instigate a program to defend the current position of the shoreline through erosion control involving a combination of beach nourishment, dune restoration and (re)construction, and hard coastal defences.
Program 1.2 Innovative erosion control approaches: Identify and assess innovative approaches to address coastal erosion, including hard structures, beach drainage and emerging technologies.
Program 1.3 Dunes restoration in a changing climate: Identify, restore and maintain coastal dune systems threatened by the impact of sea level rise and extreme erosion.
Program 2.1 Storm tides defence system: Avoid inundation of vulnerable coastal communities under current and future storm tide events by combining hard and soft defence options to minimize the risk of storm tide inundation.
Program 3.1 Retreat from high coastal hazard areas: Develop innovative methods to retreat from areas at risk, including voluntary and compulsory mechanisms such as land swap, land purchase and resumption, land surrender, rolling easements and coastal setbacks to retreat from areas at risk from erosion and storm tides.
Program 3.2 Restoration of coastal environments: Remove buildings and infrastructure affected by erosion and inundation and those within retreat areas and restore ecosystem functions of beaches, dunes, wetlands and riparian environments.
Program 4.1 Space for water: New space should be identified to allow extreme water levels to be accommodated during storm tides.
Program 4.2 Design standards for buildings and infrastructure: Buildings and infrastructure designs can be improved to accommodate extreme water levels during storm tides. These changes should apply to new and existing buildings and infrastructure.
Program 5.1 Community capacity and engagement programs: Create capacity and engagement programs for coastal rehabilitation and restoration including programs for dunes and wetlands restoration.
Program 5.2 Enhanced coastal education programmes: Integrate climate adaptation into existing school education programs (primary and secondary levels).
Program 5.3 Enhanced institutional capacities to manage coastal hazards: Build capacity of council officers and other relevant organization to manage coastal hazard areas in a changing climate.

Example of adaptation actions

Defend



Policy 1. Sandy shorelines must be prepared for future coastal erosion events associated with climate variability and change.

Program 1.1 Beach nourishment in a changing climate: Instigate a program to defend the current position of the shoreline through erosion control involving a combination of beach nourishment, dune restoration and (re)construction, and hard coastal defences.

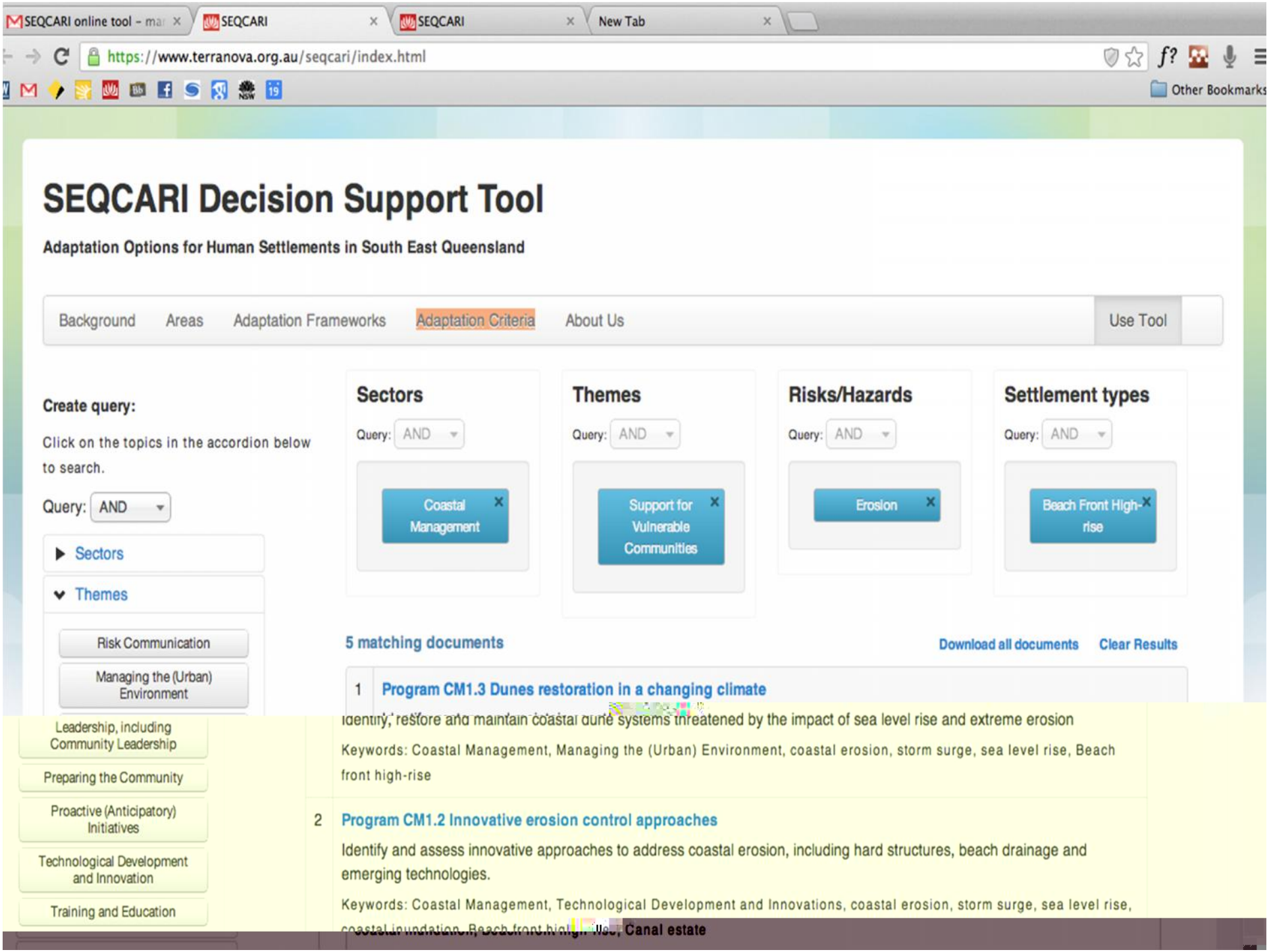
Action 1.1.1: Set-up a monitoring system for shoreline position and sand volumes.
Action 1.1.2: Identify strategic sand deposits including rivers, offshore and quarries.
Action 1.1.3: Identify current and future volumes needed for sand replenishment.
Action 1.1.4: Assess the best available option or combination of options for beach nourishment in the future.
Action 1.1.5: Couple dune restoration and beach nourishment programs.

Testing hypothetical location

Scenario planning* approach:

- **Hypothetical** case study areas
- **Workshops** with stakeholders
- **Testing** adaptation actions under combined climatic and socio-economic scenarios

*Scenario planning, is a strategic planning method to make flexible long-term plans. It is in large part an adaptation and generalization of classic methods used by military intelligence (shoemaker, 1995), Shoemaker PJH 1995. Scenario planning: a tool for strategic thinking. Sloan Management Review 36 (2), 25–40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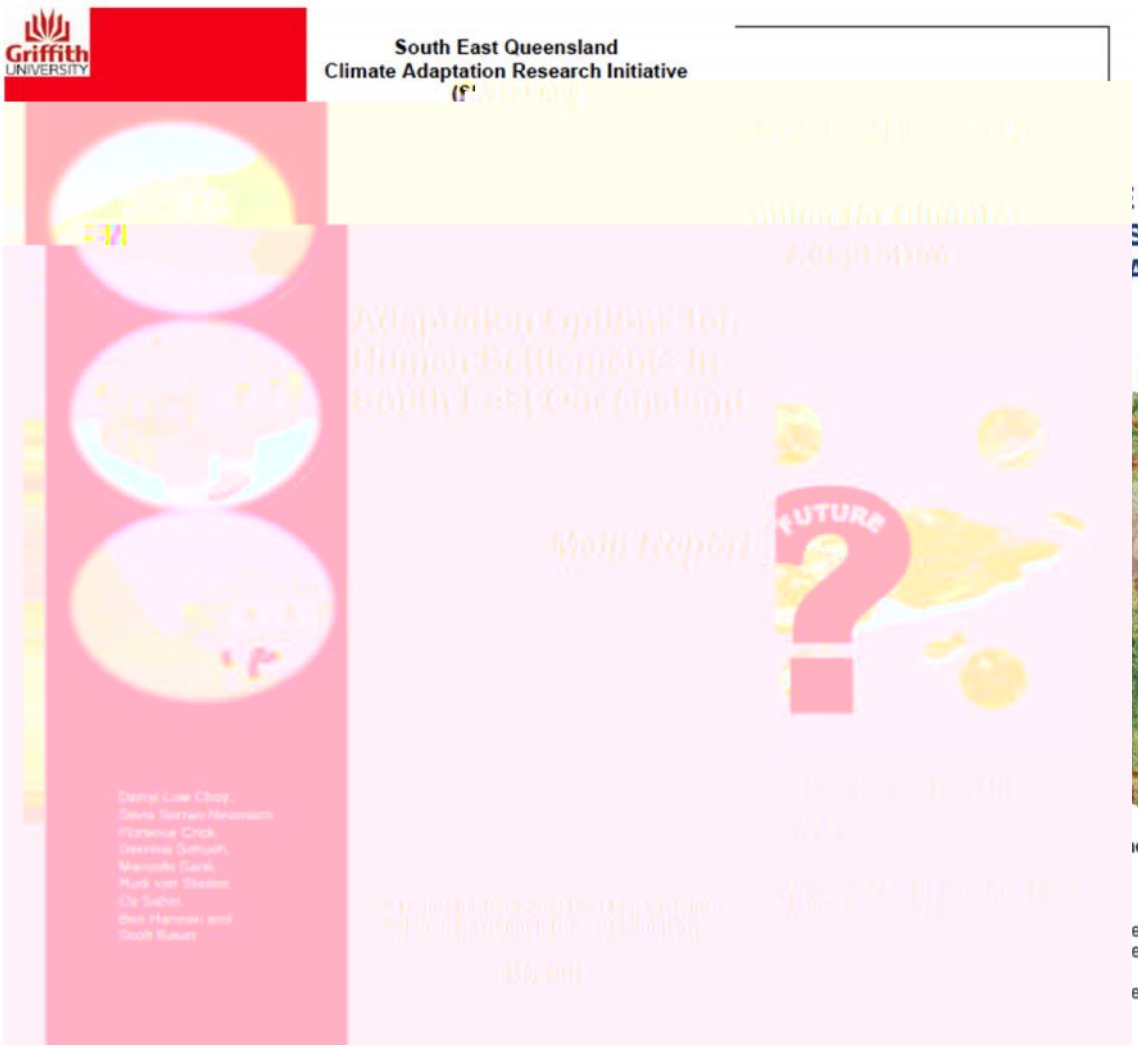
New Tab
https://www.terranova.org.au/seqcari/index.html
Other Bookmarks
SEQCARI Decision Support Tool
Adaptation Options for Human Settlements in South East Queensland
Background
Areas
Adaptation Frameworks
Adaptation Criteria
About Us
Use Tool
Create query:
Click on the topics in the accordion below to search.
Query: AND
Sectors
Themes
Risk Communication
Managing the (Urban) Environment
Leadership, including Community Leadership
Preparing the Community
Proactive (Anticipatory) Initiatives
Technological Development and Innovation
Training and Education
Sectors
Query: AND
Coastal Management
Themes
Query: AND
Support for Vulnerable Communities
Risks/Hazards
Query: AND
Erosion
Settlement types
Query: AND
Beach Front High-rise
5 matching documents
Download all documents
Clear Results
1 Program CM1.3 Dunes restoration in a changing climate
identify, restore and maintain coastal dune systems threatened by the impact of sea level rise and extreme erosion
Keywords: Coastal Management, Managing the (Urban) Environment, coastal erosion, storm surge, sea level rise, Beach front high-rise
2 Program CM1.2 Innovative erosion control approaches
Identify and assess innovative approaches to address coastal erosion, including hard structures, beach drainage and emerging technologies.
Keywords: Coastal Management, Technological Development and Innovations, coastal erosion, storm surge, sea level rise,
Canal estate

Reports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Climate Adaptation Research Initiative
FUTURE


VULNERABILITY IN
SLAND: A SPATIAL AND
ASSESSMENT
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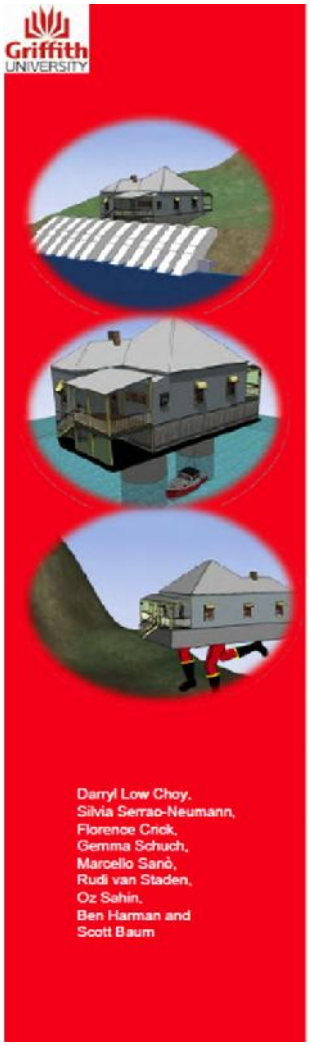
te Adaptation Research Initiative
Jan McDonald (ed)
Contributing authors
Scott Baum
Florence Crick
Jill Czarnecki
Grace Field
Darryl Low Choy
Jan McDonald
Johanna Mustelin
Marcello Sanò
Silvia Serrao-Neumann

Compendium


Griffith UNIVERSITY
South East Queensland
Climate Adaptation Research Initiative
(SEQ CARI)
Adaptation Options for
Human Settlements in
South East Queensland
Main Report
Darryl Low Choy,
Silvia Serrao-Neumann,
Florence Crick,
Gemma Schuch,
Marcello Sanò,
Rudi van Staden,
Oz Sahin,
Ben Harman and
Scott Baum
A report for the South East Queensland
Climate Adaptation Research Initiative
May 2012

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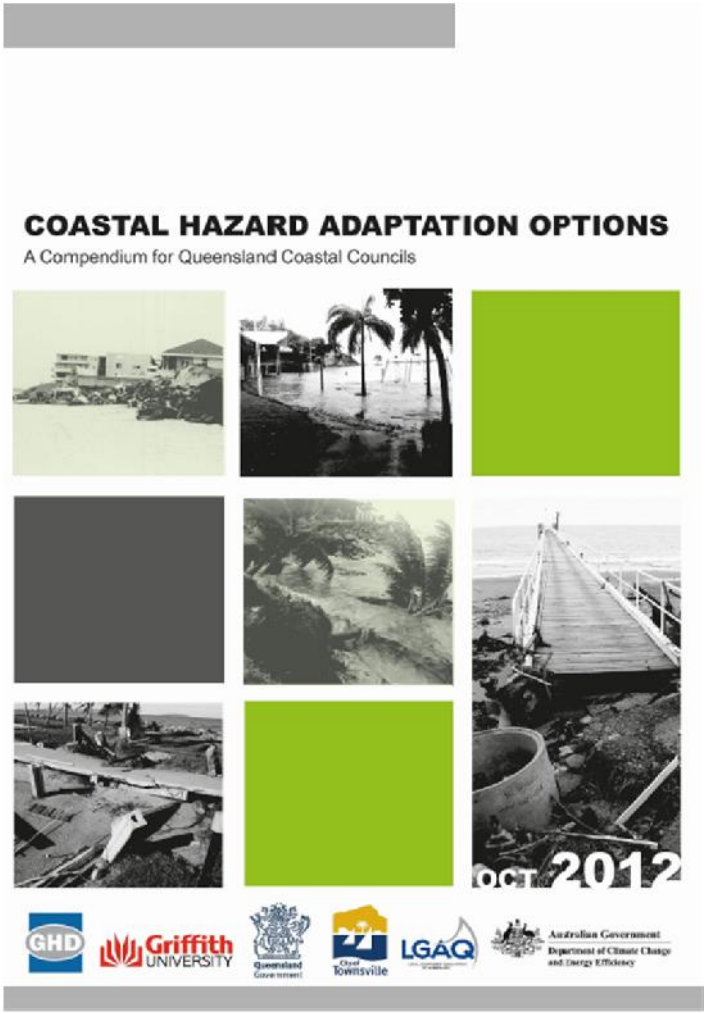
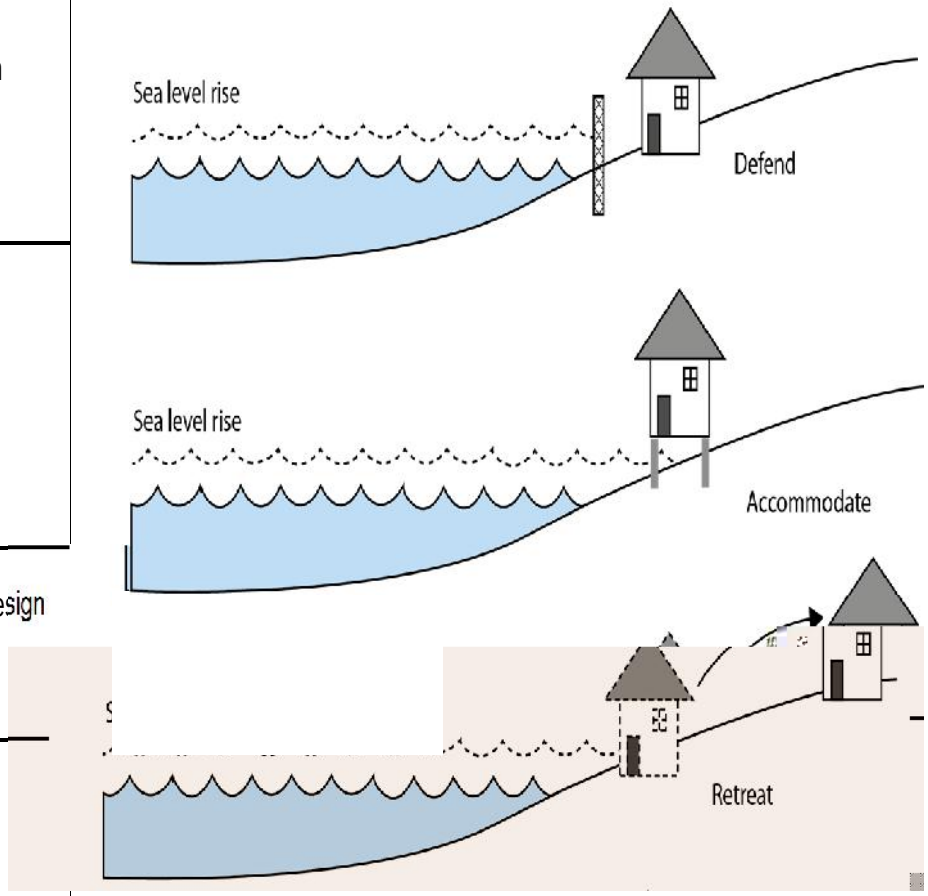

COASTAL HAZARD ADAPTATION OPTIONS
A Compendium for Queensland Coastal Councils
OCT 2012
GHD
Griffith UNIVERSITY
LGAQ

Townsville

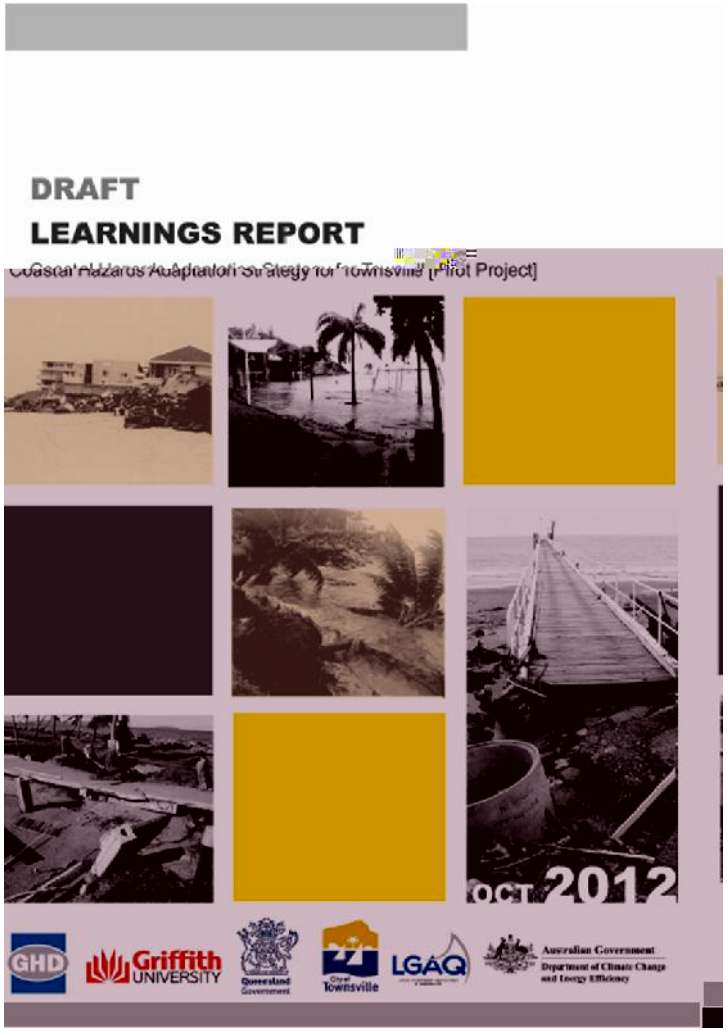

Western Australia
Northern Territory
Queensland
South Australia
New South Wales
Victoria
Tasmania
LGAQ
LOCAL GOVERNMENT ASSOCIATION OF QUEENSLAND
Queensland Government
City of Townsville
GHD

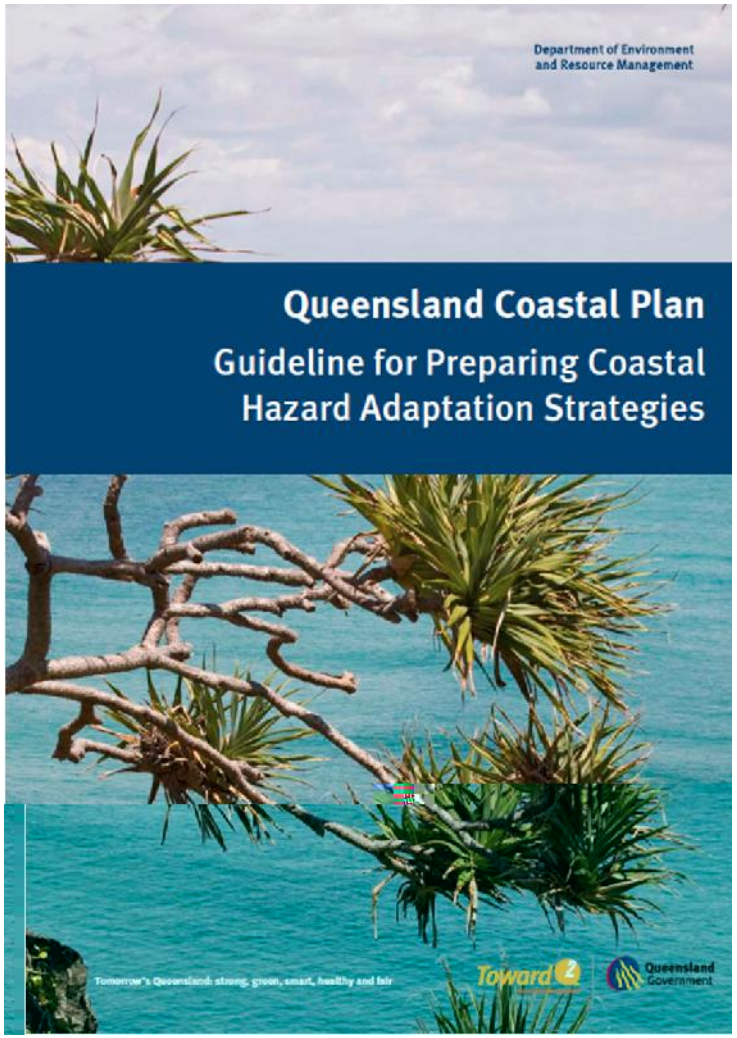
Compendium

1. Regenerative options	1.1 Beach nourishment 1.2 Dune construction and regeneration 1.3 Riparian corridor restoration and generation 1.4 Wetland restoration
2. Coastal engineering options	2.1 Artificial reefs 2.2 Detached breakwaters 2.3 Groynes and artificial headlands 2.4 Sea dykes 2.5 Seawalls 2.6 Storm surge barriers
3. Coastal settlement design options	3.1 Building retrofitting and improved design 3.2 Flood-resilient public infrastructure 3.3 Raise land levels
4. Planning options	4.1 Development setbacks 4.2 Land buy-back 4.3 Land swap 4.4 Land-use planning



Updating policy





Training

Monday 29 of April

- Coastal Processes and impacts
- Coastal modeling
- Impacts, vulnerability and risk
- Shoreline erosion management
- Coastal hazard adaptation

Tuesday 30 of April

- Policies and planning
- Stakeholder engagement
- Shoreline Erosion Management Plans
- Coastal Hazard Adaptation Strategies
- Case studies

Partnerships in the Asia-Pac

- Melanesian Spearhead Group
- ACCA21 MoU, China
- Open to future collaborations

Acknowledgements

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Prof Cordia Chu, **Griffith Centre for Environment and Population Health**

Thank you