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**HAZARDS**CRC

## DYNAMIC COASTS

Improving Community Resilience to Storms and  
Extreme Water Levels along the Coast

**Jane Sexton**

**Community Safety and Earth Monitoring Division, Geoscience Australia**

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Australian Government  
Department of Industry,  
Innovation and Science

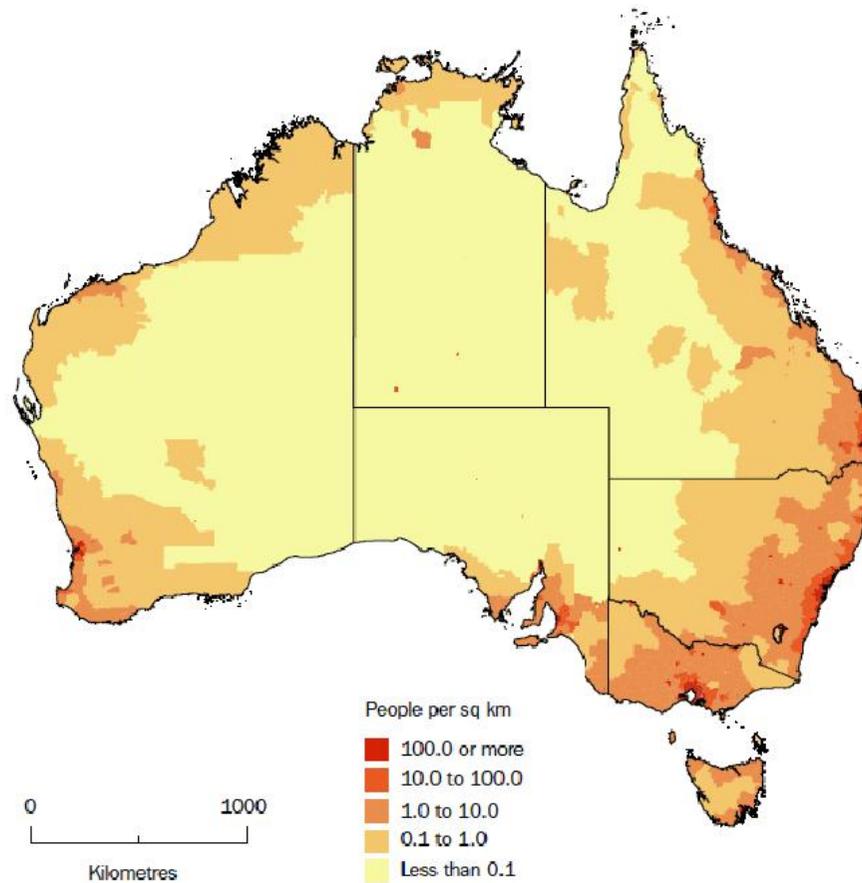
**Business**  
Cooperative Research  
Centres Programme



Australian Government  
Geoscience Australia

# AUSTRALIA IS A COASTAL SOCIETY

~85% of Australia's population lives within 50 km of the coast



Source: *Regional Population Growth, Australia (3218.0)*.



April 2003

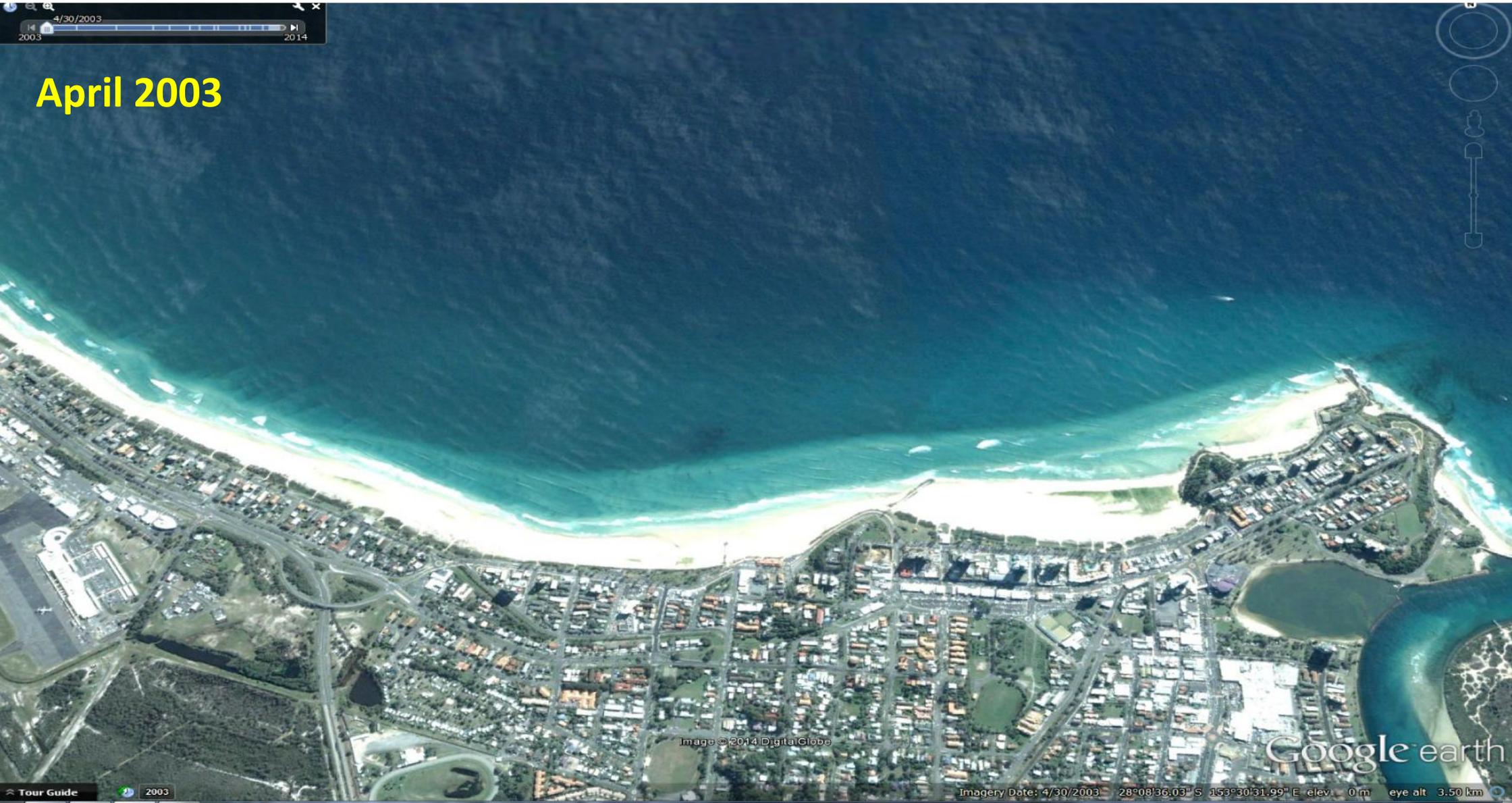


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Google earth

Tour Guide 2003

Imagery Date: 4/30/2003 28°08'36.03" S 153°30'31.99" E elev. 0 m eye alt 3.50 km

9/24/2006

Oct 2004

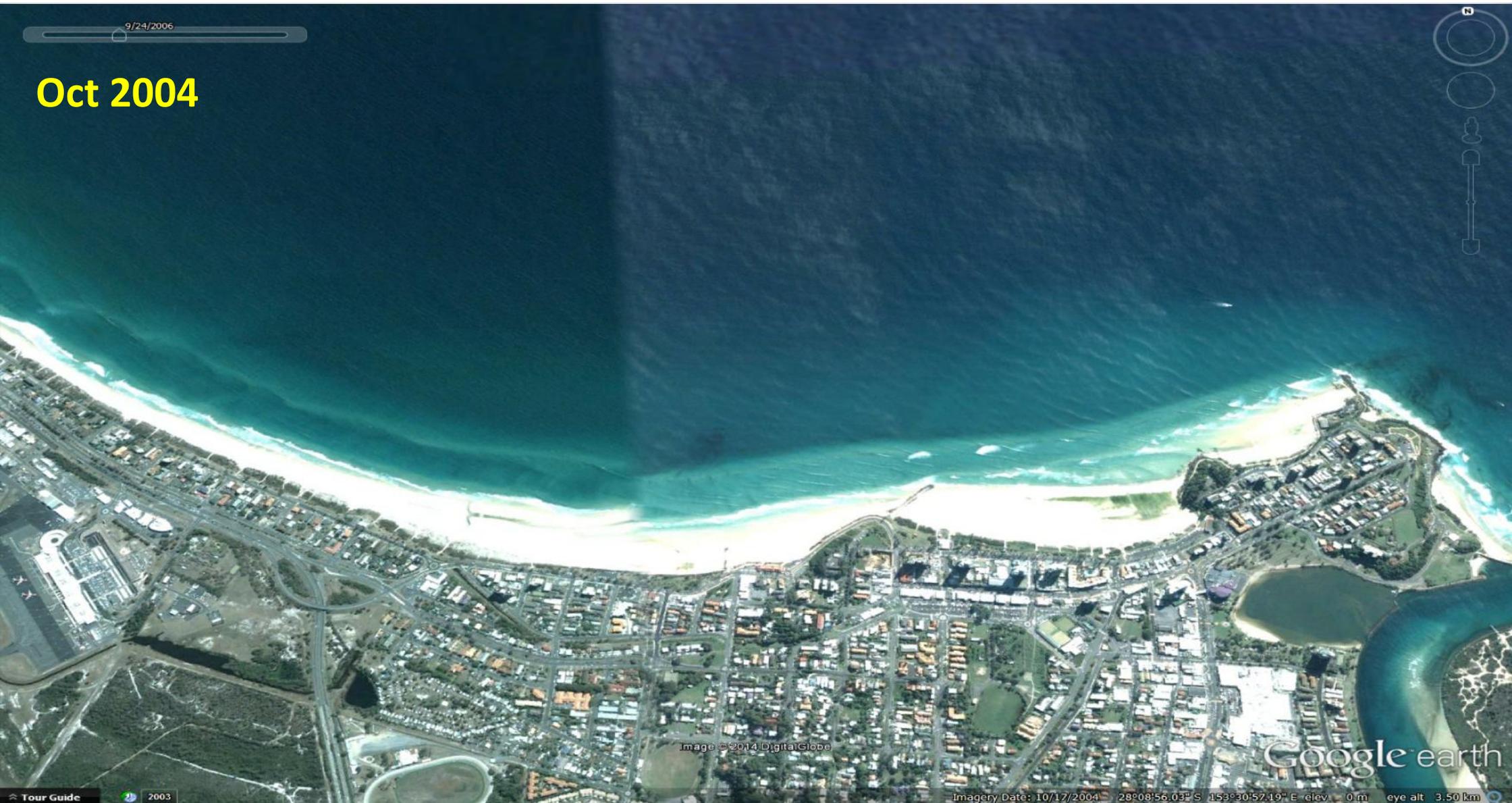


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Tour Guide 2003

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6/26/2008  
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2003 2014

June 2008

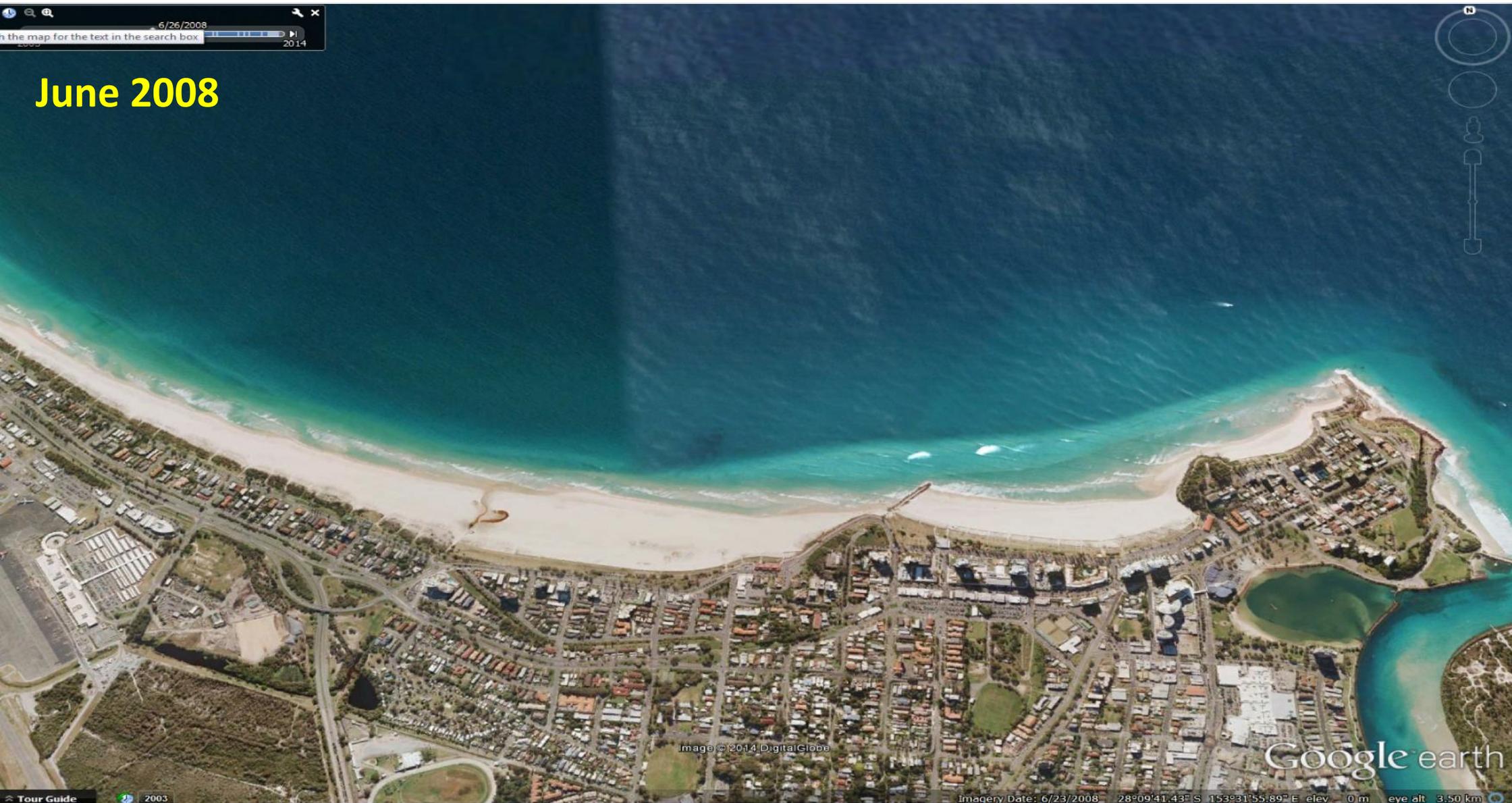


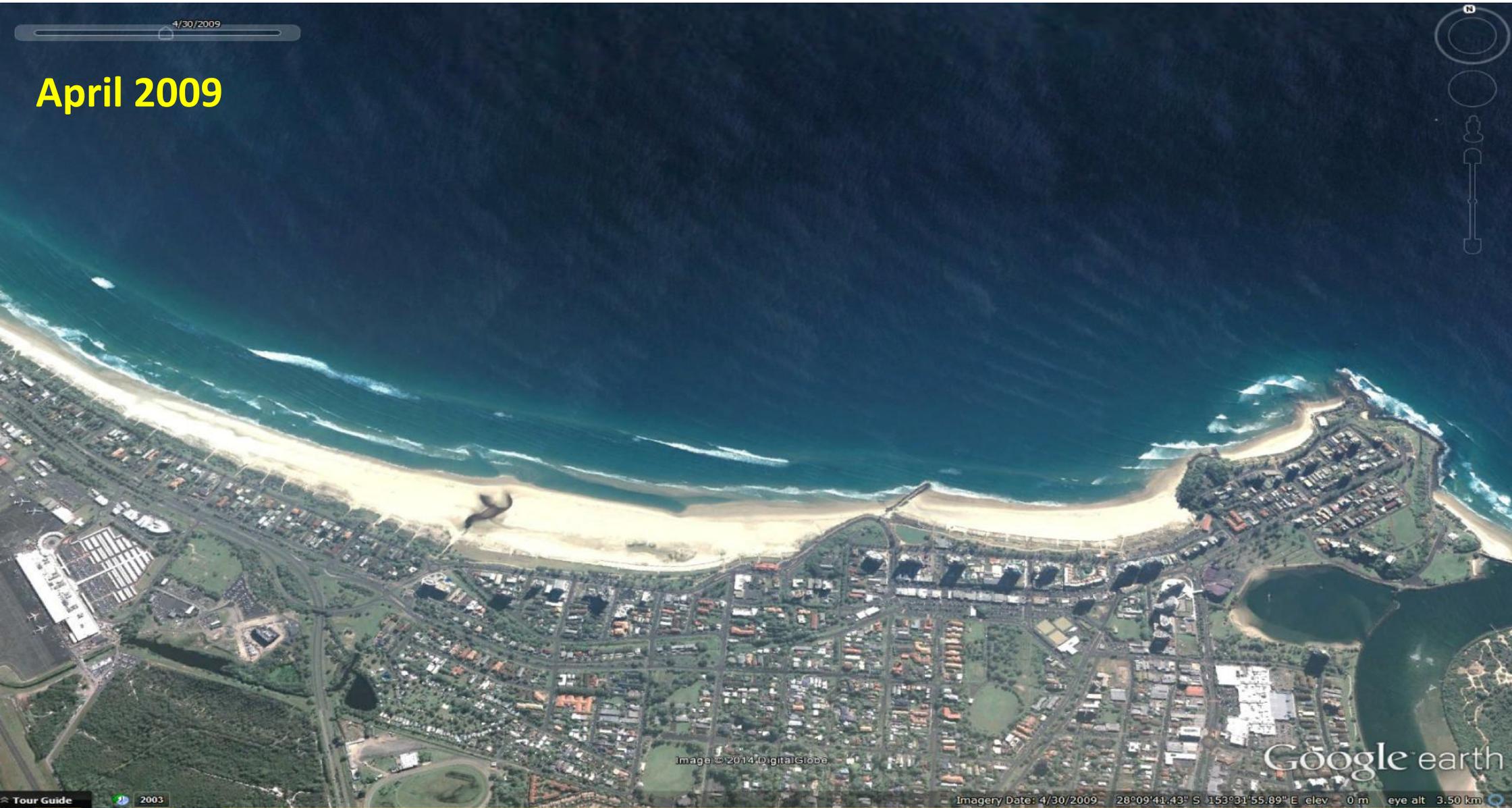
Image © 2014 DigitalGlobe

Google earth

Tour Guide 2003 Imagery Date: 6/23/2008 28°09'41.43" S 153°31'55.89" E elev. 0 m eye alt. 3.50 km

4/30/2009

# April 2009



Tour Guide 2003

Imagery Date: 4/30/2009 28°09'41.43" S 153°31'55.89" E elev. 0 m eye alt 3.50 km

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[bnhcrc.com.au](http://bnhcrc.com.au)

4/11/2010  
2003 2014

April 2010

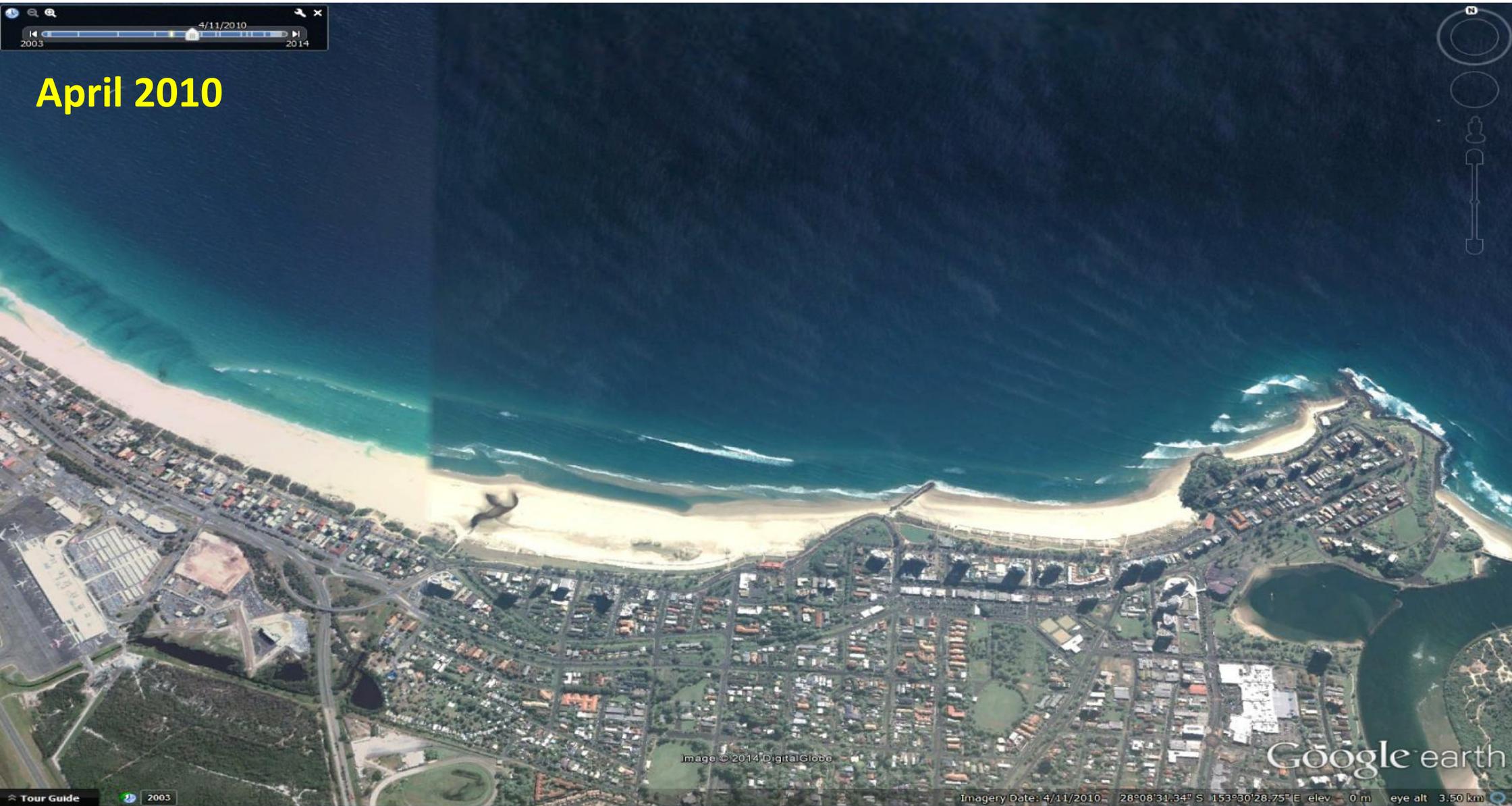


Image © 2014 DigitalGlobe

Google earth

Tour Guide 2003

Imagery Date: 4/11/2010 28°08'31.34" S 153°30'28.75" E elev 0 m eye alt 3.50 km

6/24/2011

# June 2011



Image © 2014 DigitalGlobe

Google earth

Imagery Date: 6/24/2011 28°08'57.17" S 153°31'16.97" E elev. 0 m eye alt 3.50 km

Tour Guide 2003

9/20/2012  
search the map for the text in the search box  
2014

Sept 2012



Image ©2014 DigitalGlobe

Google earth

Imagery Date: 9/20/2012 28°09'41.43" S 153°31'55.89" E elev 0 m eye alt 3.50 km

Tour Guide 2003

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11/2/2013

Nov 2013



Image ©2014 DigitalGlobe

Google earth

Imagery Date: 11/2/2013 28°09'00.68" S 153°31'19.58" E elev 0 m eye alt 3.50 km

Tour Guide 2003

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[bnhcrc.com.au](http://bnhcrc.com.au)



April 2014

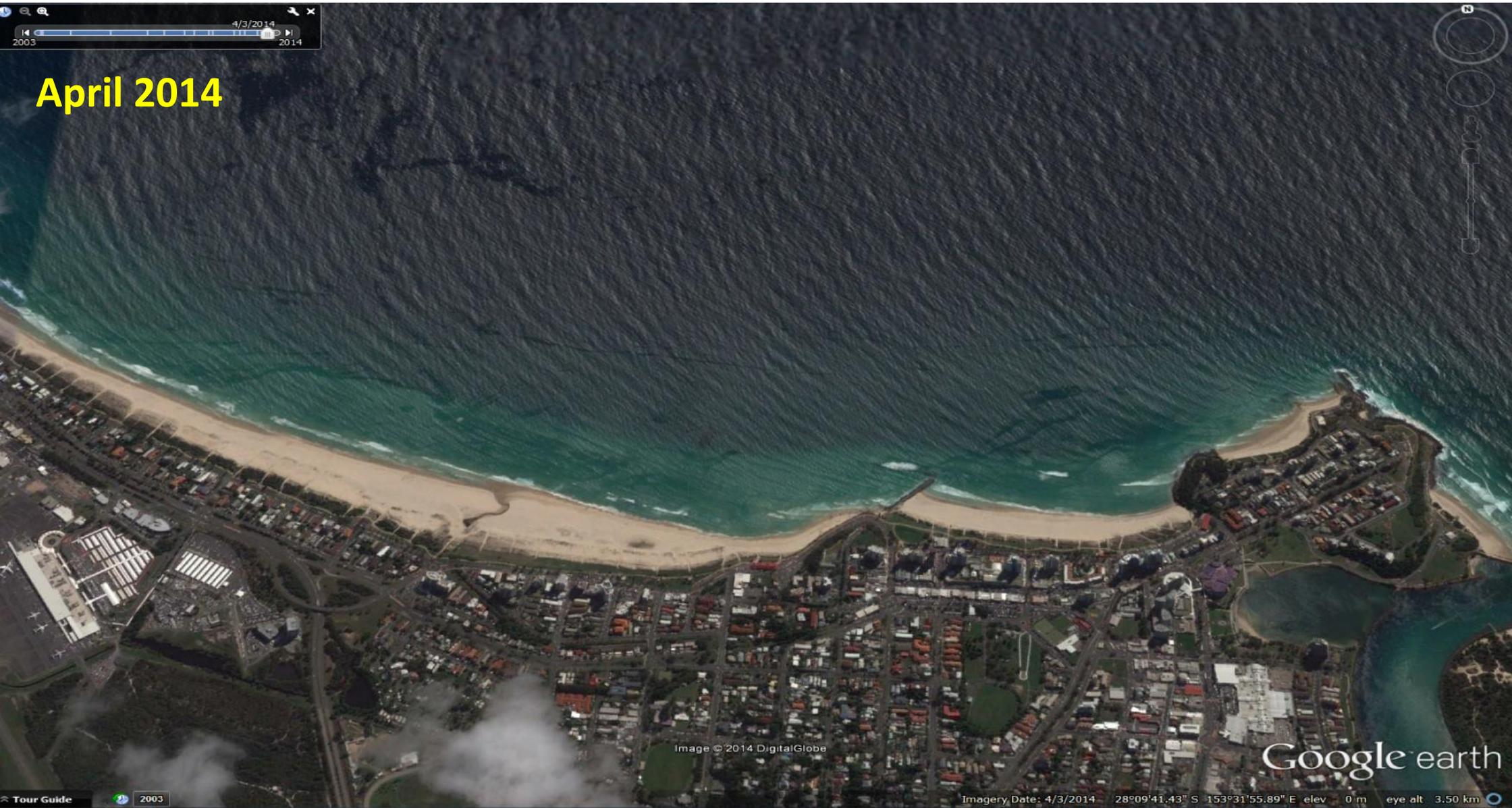


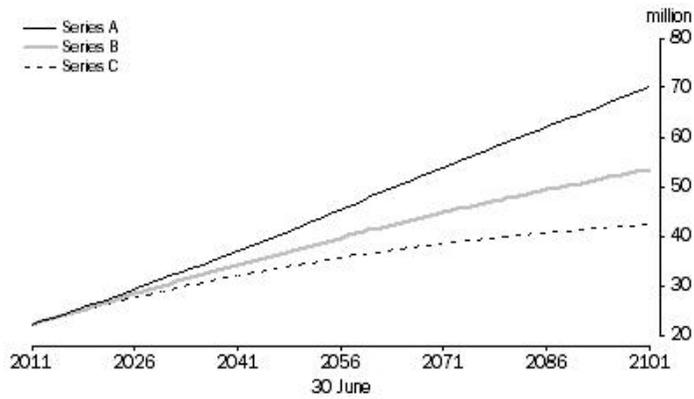
Image © 2014 DigitalGlobe

Google earth

Tour Guide 2003

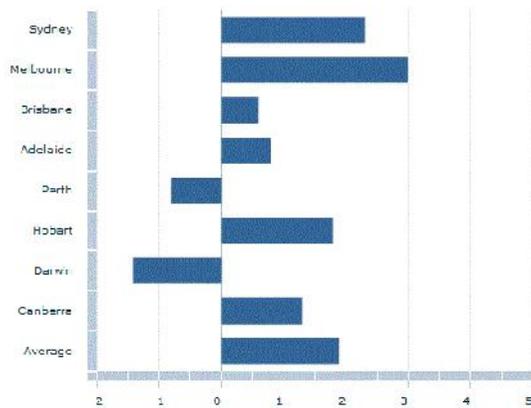
Imagery Date: 4/3/2014 28°09'41.43" S 153°31'55.89" E elev 0 m eye alt 3.50 km

# INCREASING VULNERABILITY



ABS

Residential Property Prices, Quarterly Percentage Change, June Quarter 2017



CLIMATE CHANGE IN AUSTRALIA  
 PROJECTIONS FOR AUSTRALIA'S NRM REGIONS

[About](#) [Future climate](#) [Explore data](#) [Climate Futures Tool](#) [Climate analogues](#) [Coastal & marine](#) [Sign-In/Register](#)

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## MARINE EXPLORER

BASIC

Configure Data

TIME PERIOD	2090	VARIABLE	Sea Level	EMISSIONS SCENARIO	RCP 2.6
PERCENTILE	MID (50th percentile)	SEASON	Annual	AUTO SCALE	<input type="checkbox"/>
					LEGEND

Source <https://www.climatechangeinaustralia.gov.au/en/climate-projections/coastal-marine/marine-explorer/>

## EVENTS IN 2016: EAST COAST LOW, 4-5 JUNE



Collaroy Beach, Sydney



## EVENTS IN 2017: TC DEBBIE



Shute Harbour, Whitsunday's



Mackay



Sunshine Coast

# FACTS AND FIGURES ON COSTS

## Extreme water levels (meteotsunami, storm surge)

- Historically low economic cost per event, however potential for large losses:
  - A tropical cyclone crossing over one of the more densely populated parts of the coast at high tide can be devastating.
  - Cost largely in ongoing management of beaches experiencing ongoing erosion.



PHOTO: Al Tenryack, only sand replenishment keeps some coastal housing safe from high tide and storm surge events.



PHOTO: Damian Spivey/Getty Images

# IMPORTANCE OF MITIGATION

- Mitigation is imperative to reduce loss of life & property. Mitigation reduces the impact of disasters.



Sandra Storey checks out the waves at the Glenelg North foreshore. Pic: Tricia Watkinson

# DEVELOPING BETTER PREDICTIONS FOR EXTREME WATER LEVELS

## Research Team

Prof Charitha Pattiaratchi  
Asst/Prof Ivica Janekovic  
Dr Yasha Hetzel  
*School of Civil, Environmental & Mining  
Engineering / UWA Oceans Institute*



## End users



Robert Schwartz



David Hanslow



Kaylene Jones



Steve Gray



James Guy

# PROJECT IMPORTANCE

- Coastal communities & infrastructure **are at increasing risk** from the impacts of extreme water level events (e.g. tides, storm surges, meteotsunamis).
- To better prepare, coastal engineers, emergency managers & planners require accurate estimates of extreme water levels.



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## Adelaide beachfront housing 'facing erosion risks' like those at Collaroy, Sydney

891 ABC Adelaide  
Updated 8 Jun 2016, 12:20am



**PHOTO:** Storm damage has left little access to West Beach in Adelaide. (Supplied City of Charles Sturt)

## WHAT HAS IT ACHIEVED?

- An advanced coupled surge-wave model for the Australian coastline
  - Allows for estimation of wave setup over large areas
  - Output: 60 year time series of water levels
- Improved extreme sea level predictions

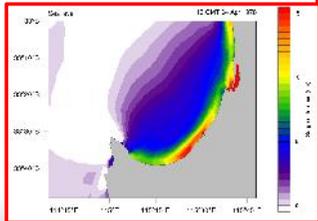
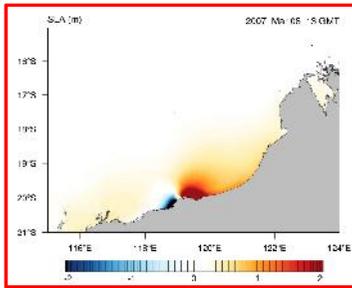
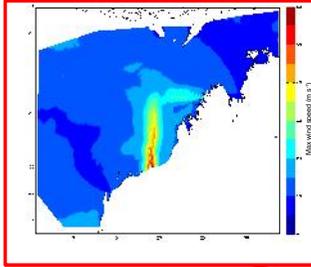


Damian Shaw Daily Telegraph

# FIVE EVENTS - MODEL VALIDATION

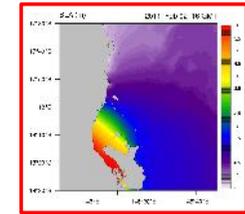
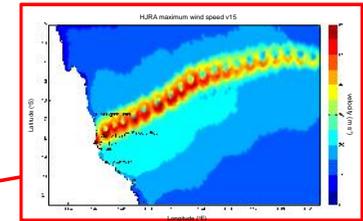
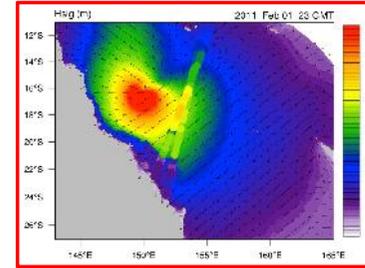
## TROPICAL CYCLONE GEORGE

APRIL 2007



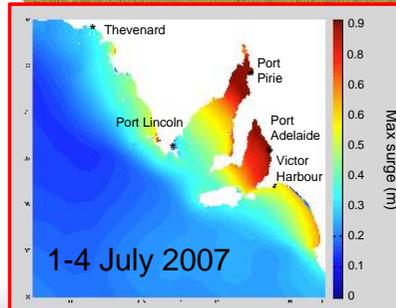
## TROPICAL CYCLONE YASI

FEBRUARY 2011

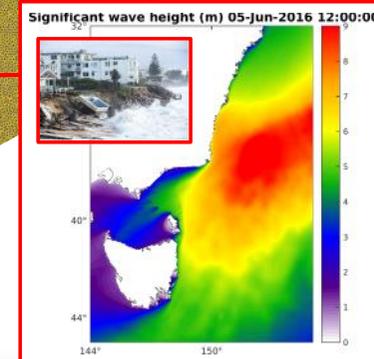


## CYCLONE ALBY

APRIL 1978



## EXTRATROPICAL STORMS



## EAST COAST

LOW JUNE 2016

## WHAT ARE THE OUTPUTS/PRODUCTS?

- A web-based tool is being developed to disseminate results of the study – includes ~100,000 coastal 'stations' around Australia & estimates of likelihood of extreme water levels.



# WHERE HAS THE WORK TAKEN US?

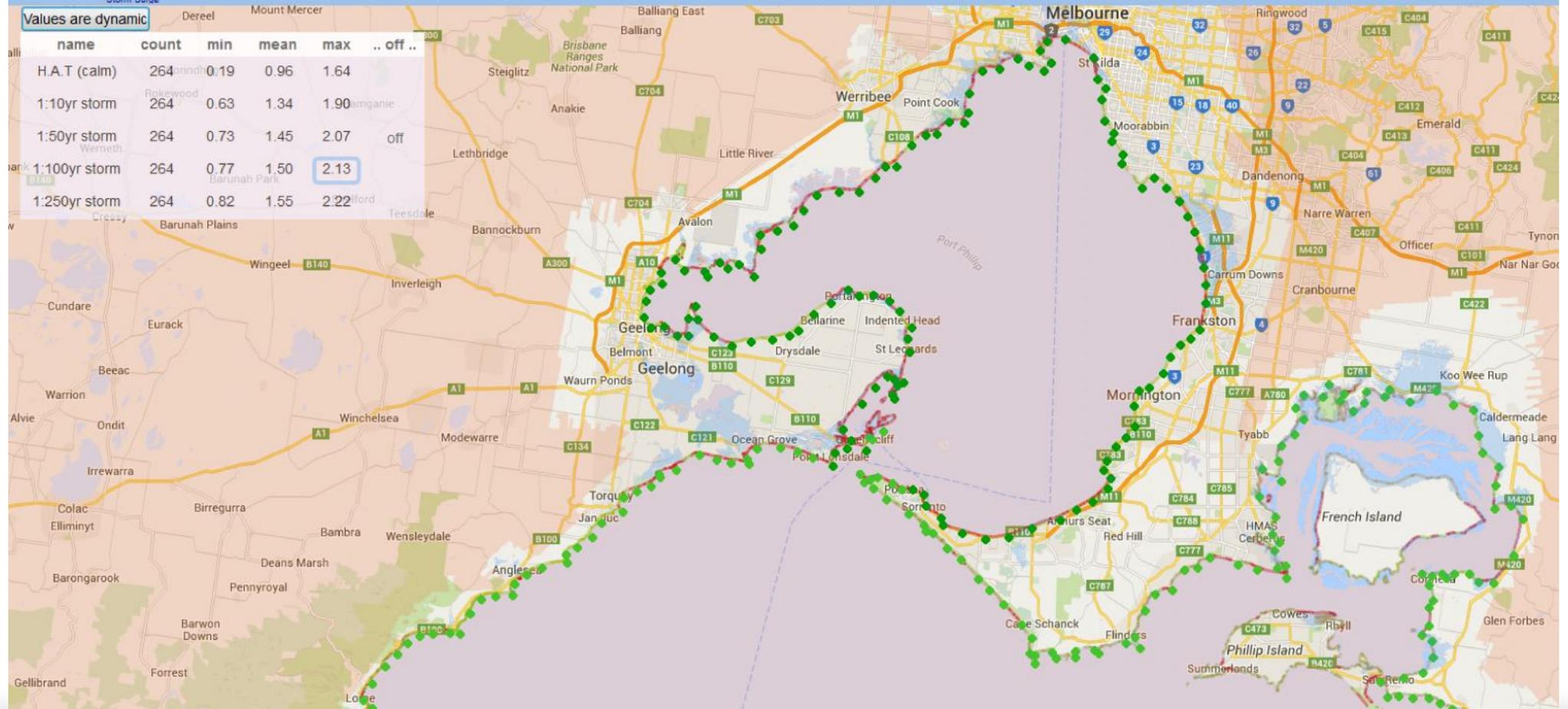
Download Contact Logout

Tides... 2.13 0.00 0.00 2.13 PDF...

Tide & Storm Surge Wave Runup Wave Setup Scenario Result

Values are dynamic

name	count	min	mean	max	.. off ..
H.A.T. (calm)	264	0.19	0.96	1.64	
1:10yr storm	264	0.63	1.34	1.90	
1:50yr storm	264	0.73	1.45	2.07	off
1:100yr storm	264	0.77	1.50	2.13	
1:250yr storm	264	0.82	1.55	2.22	



# RESILIENCE TO CLUSTERED DISASTER EVENTS AT THE COAST: STORM SURGE

## Leading to improved knowledge in the coastal zone

### Research Team

Dr Scott Nichol (Leader)  
Dr Gareth Davies  
Dr Andrew McPherson  
Dr Wenping Jiang  
Floyd Howard  
Duncan Moore  
Dr Jane Sexton (Manager)



**Australian Government**  
**Geoscience Australia**

Professor Tom Baldock  
Dr David Callaghan  
Dr Uriah Gravois



**THE UNIVERSITY**  
**OF QUEENSLAND**  
AUSTRALIA

### End users



Dave Hanslow



Robert Schwartz

Paul Boswood



**Government of South Australia**  
Department of Environment,  
Water and Natural Resources

James Guy

## CONTEXT

# Harvey, Irma, Jose, Maria: No, the 2017 hurricane season is not normal

By Maggie Astor, New York Times  
Wednesday, September 20, 2017 5:14pm



It was only 27 days ago that Hurricane Harvey made landfall.

### RELATED NEWS/ARCHIVE

**Yep, 2017 hurricane season really is more intense than normal**  
1 Month Ago

**Maria upgraded to hurricane; Jose lingering in the Atlantic**  
1 Month Ago

**Hurricane Irma lashes Cuba, with Jose close behind**

You could be forgiven for thinking it's been longer. After all, that was four hurricanes ago.

We crunched the numbers and talked to an expert, and it's not your imagination: The 2017 Atlantic hurricane season has been unusually active.



NASA/NOAA GOES Project via New York Times

*Sept. 8: Tropical Storm Katia, from left, Hurricane Irma and Jose, not yet a hurricane. Nine days later, Maria would become a hurricane.*

# HURRICANE IRMA, SEPTEMBER 2017



Vilano Beach, Florida, following TC Irma, 2017, Reuters.



Public walkway destroyed by TC Irma, 2017, Brad Nettles/Staff.

# STORM SURGE AND COASTAL INUNDATION



Gerben Van Es/Dutch Defense  
Ministry/AFP/Getty Images



Inundation in Miami during Hurricane Irma, 2017.  
Pedestrian TV.



Hurricane Irma inundation on St Martin Island, 2017.  
Rinsy Xieng / Twitter

## PROJECT IMPORTANCE

- Coastal communities & infrastructure **are at risk** from the impacts of storm surge
- Clustered surge events **reduces time for recovery** of the coastline
- Not accounting for the impact of clustered events **underestimates the risk** to coastal assets

Coastal managers require information & tools to better understand coastal erosion → **Where? How much? Why?**

Images:

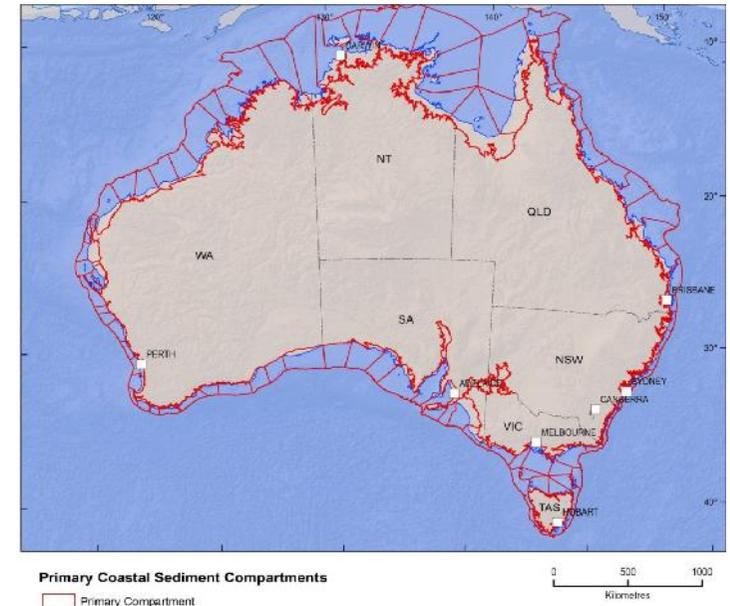
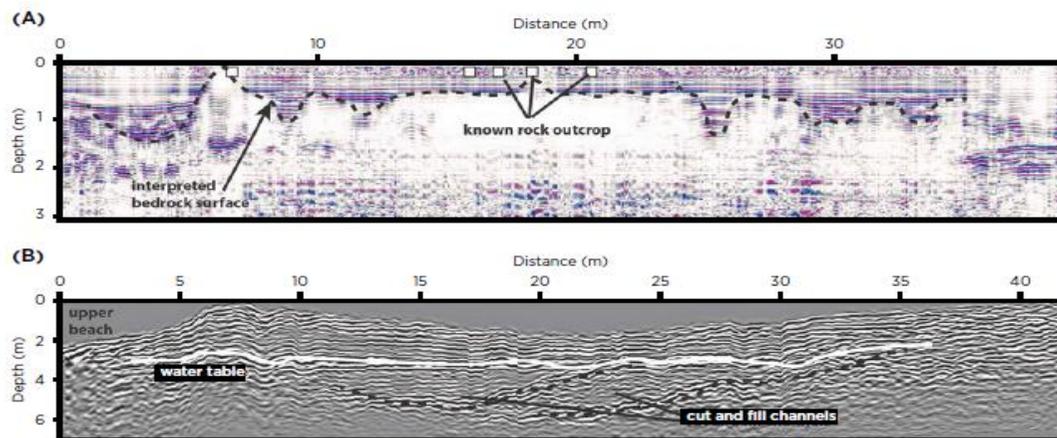
- TC Debbie March 2017 – Shute Harbour
- Ex-TC Debbie April 2017 – Gold Coast (Surf Life Saving QLD)
- Storms May 2016 - Adelaide
- East Coast Low June 2016 - Collaroy Beach, Sydney



# WHAT ARE THE OUTPUTS/PRODUCTS?

## Data for coastal managers

- The **'where'**
  - Australian coastal sediment compartments dataset
- The **'how much'**
  - Wave & sediment data for study sites
- The **'why'**
  - Shoreline response models with maps
  - Supporting software (GITHUB)



## EXAMPLE RESULTS: OLD BAR, NSW



- 50 yr return period 'storm series' event
- Assumes no shoreline management strategies in place (e.g. sand bagging)



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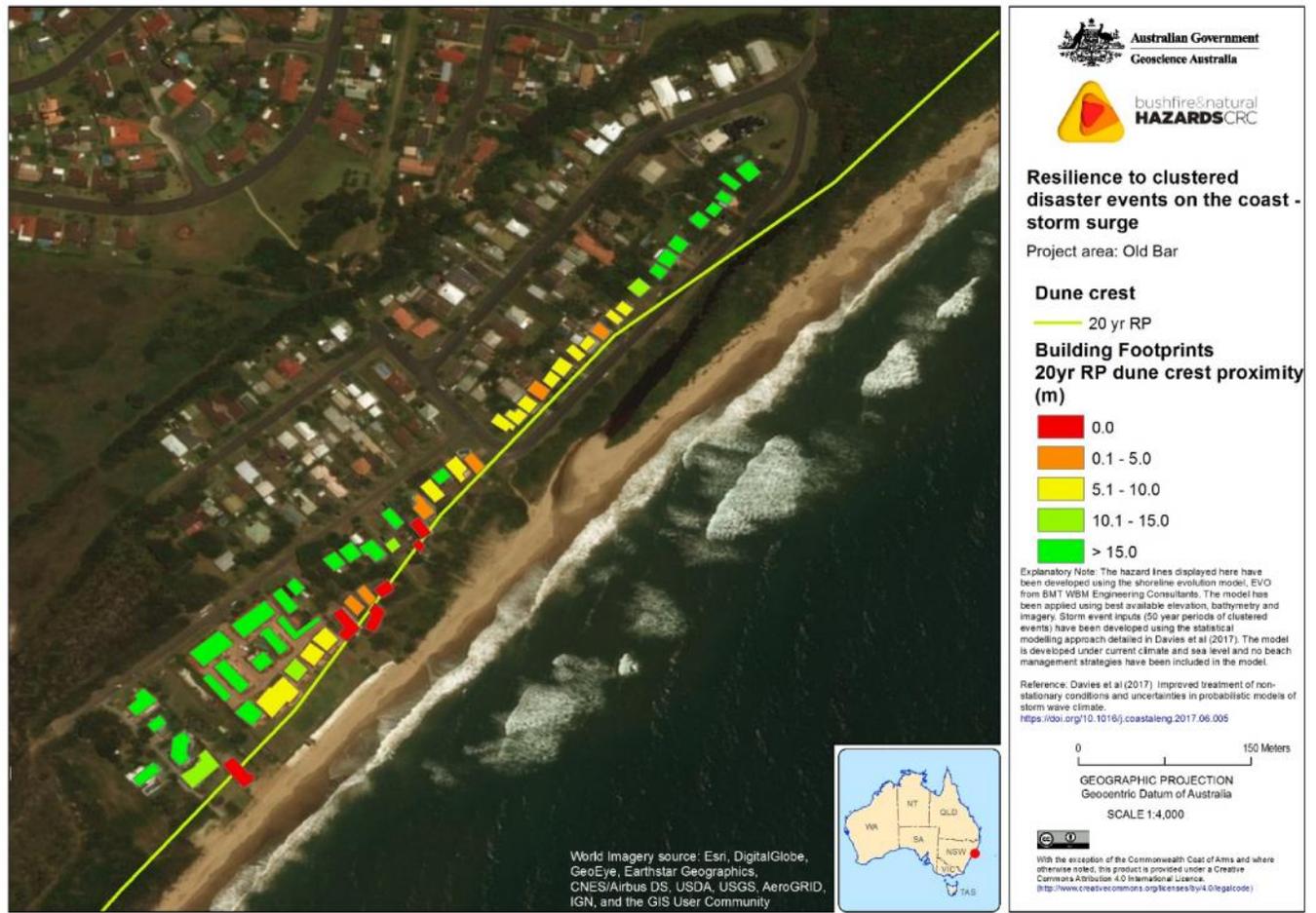
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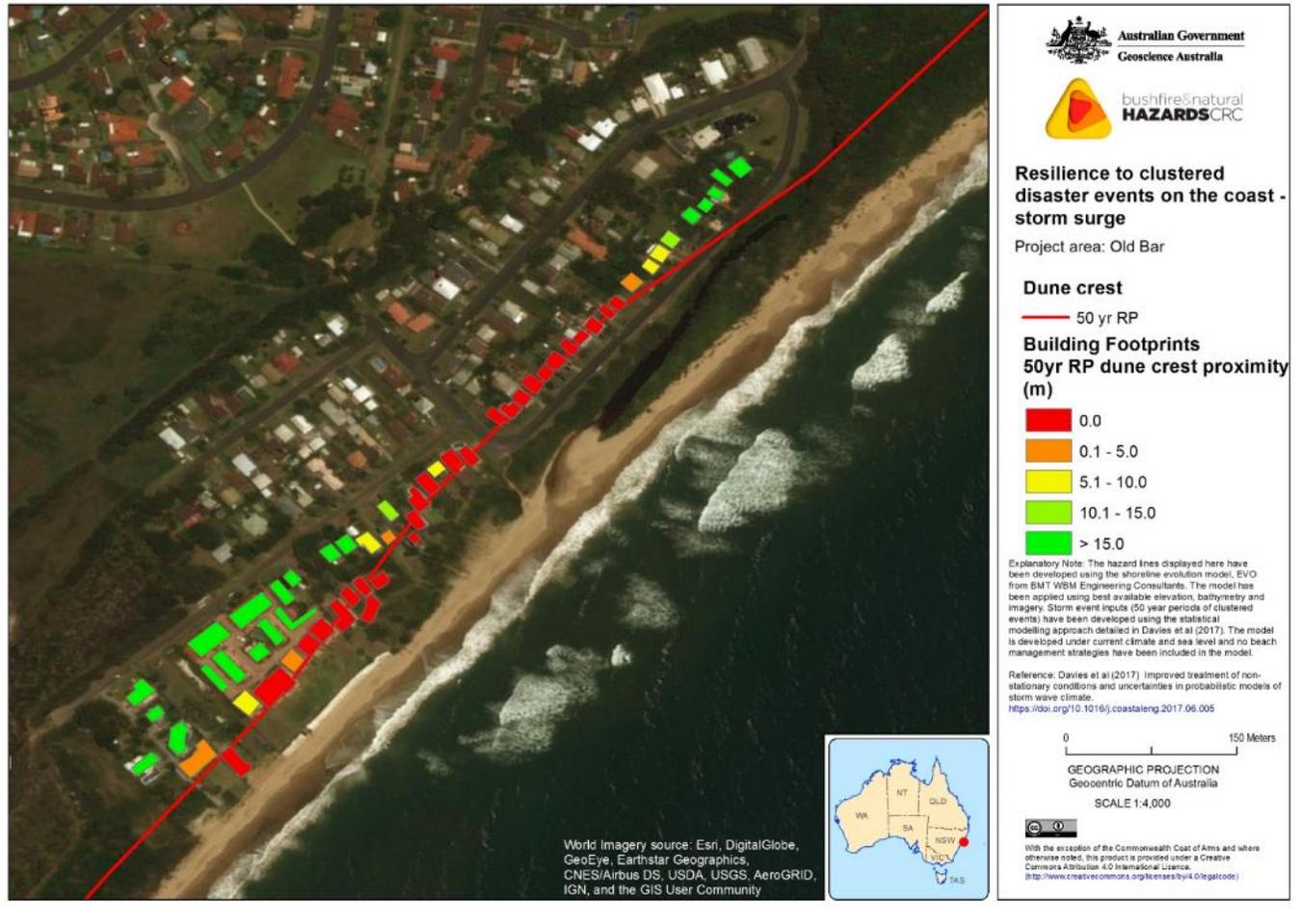
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## WHERE HAS THIS WORK TAKEN US?

- Recognition that application of the method will be typically applied by consultants working for emergency management & coastal management sector
  - Provide guidance, use-cases where possible to increase potential for up-take
- Knowledge base has been improved for end-users
  - Continue to communicate & promote outputs for broader knowledge transfer
- Modelling is improving the fundamental understanding of coastal processes in erosion hotspots

# WHAT WILL IT ACHIEVE?

## **Hazard Assessment – Existing Development:**

- Improved assessment of existing hazard

## **Protection of Future Development:**

- Improved assessment of erosion buffers

## **Improved management of Australia's Urban Beaches**

## ISSUES REMAINING – COASTAL PROJECTS

### Implementation challenges for national application



- Availability of national datasets at appropriate scales
  - Coastal infrastructure
  - Wave & sea level observations that are of sufficient duration (i.e. 10+ yrs)
  - High resolution bathymetry & elevation
- Uptake of highly technical methods that rely on data & capability of users
- Construction of coastal inundation maps for extreme water levels (including climate change effects)

# ISSUES REMAINING – COASTAL PROJECTS

## Science Challenges

- Model coastal processes at longer time scales (decades & longer) to fully understand coastal behavior
- Translate/communicate the science (and uncertainty) to decision makers so that effective mitigation strategies are adopted
- Impact of climate change



# QUESTIONS

