Understanding coastal processes through monitoring

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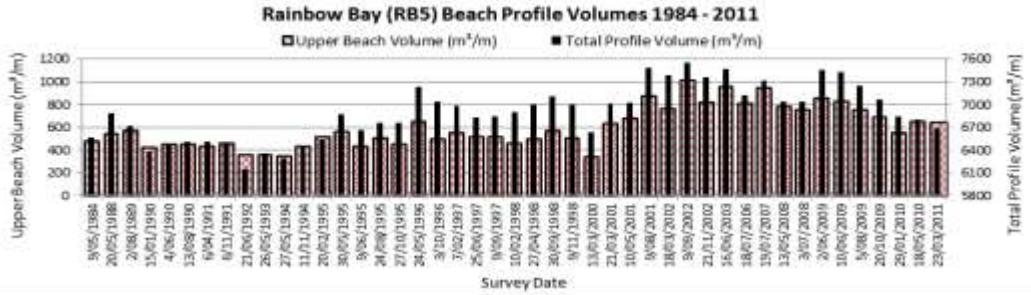
GCCM Coastal Research

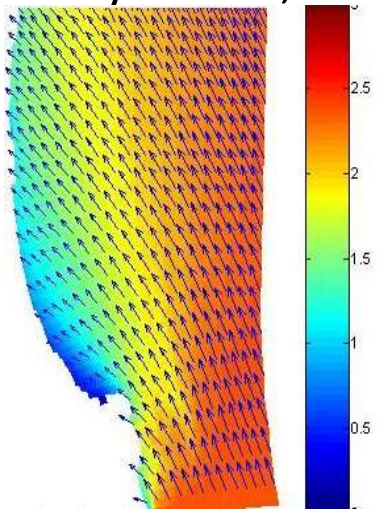
- Coastal infrastructure and natural asset management
- Catchments and waterways
- Water future
- Climate Change and adaptation
- Extreme events and disaster management
- Community engagement and education – CoastED and BeachCare
- Beach and estuarine ecology
- Economic values

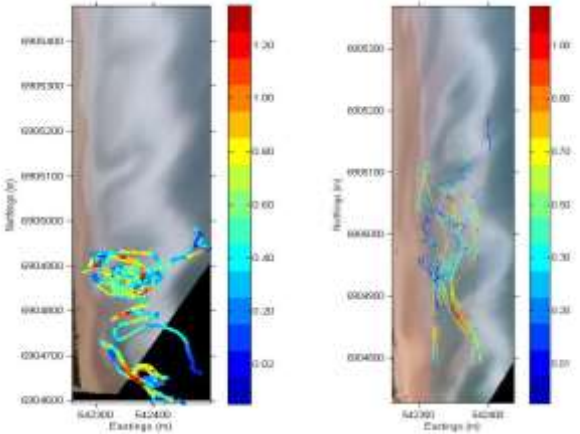


Research Interests

- Coastal Geomorphology and Oceanography
- Beach and Surf Morphology, Rip Currents
- Extreme Events, Beach Erosion & Recovery
- Numerical Modelling - Waves, hydrodynamics, sediment transport


Flash Rip - Coolangatta





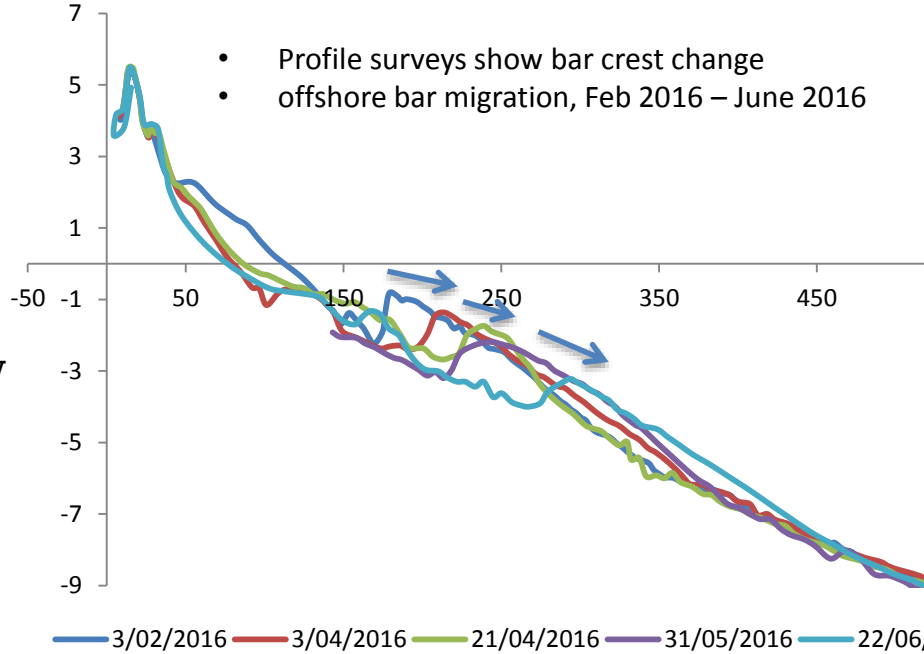
Morphodynamic Response to Large Scale Nearshore Beach Nourishment

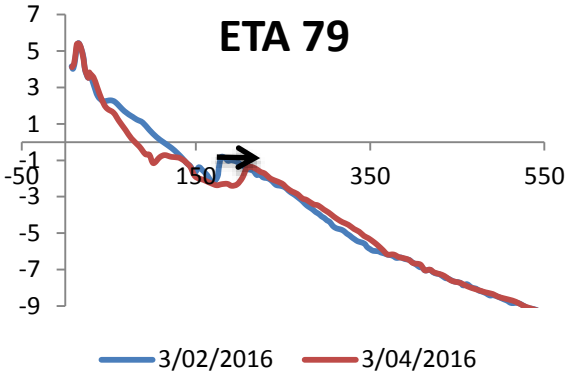
Dr Darrell Strauss, Dr Tom Murray, Ms Gaelle Faivre

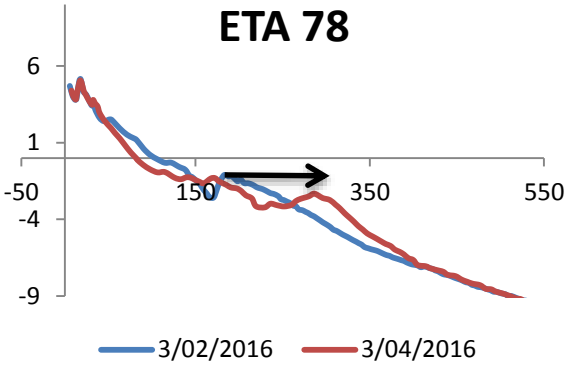
Advance Qld Research Fellowship 2016-2019
City of Gold Coast Research Program
Griffith University

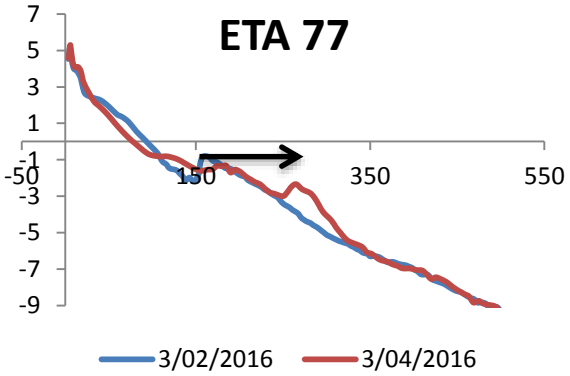
Aims

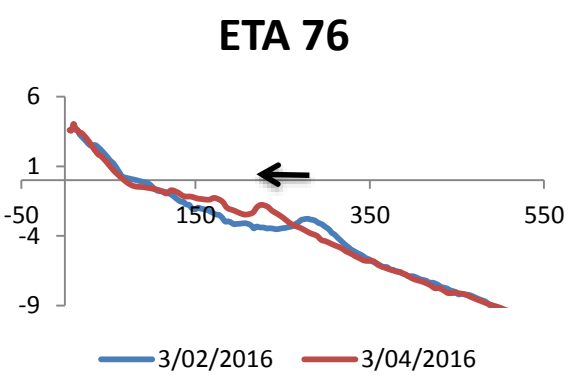
- develop process understanding and numerical modelling capability of sand transport in shallow water waves and currents
- particular focus on the onshore movement of sand
- high-resolution field-scale measurements of bar responses to a large-scale nearshore nourishment projects on Gold Coast beaches.







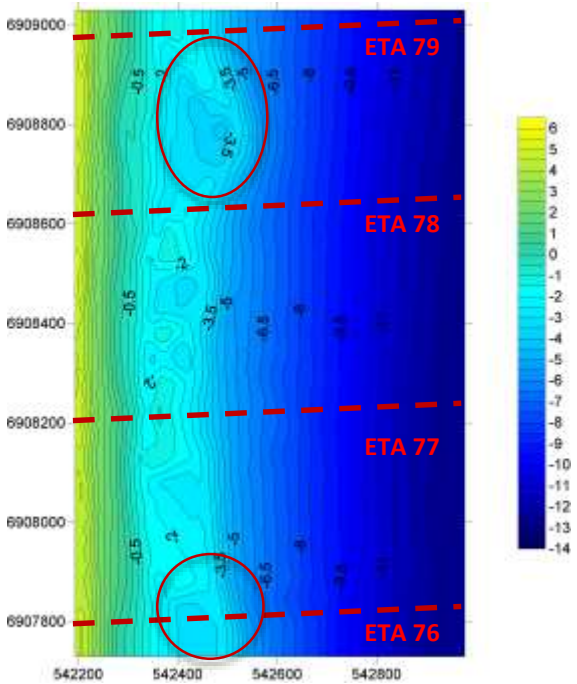




Inconsistent bar response at 400m transects

requires higher resolution surveys for process understanding and numerical model validation

High resolution survey reveals shoreward migration at ETA76 but also in between profiles ETA78 & ETA 79



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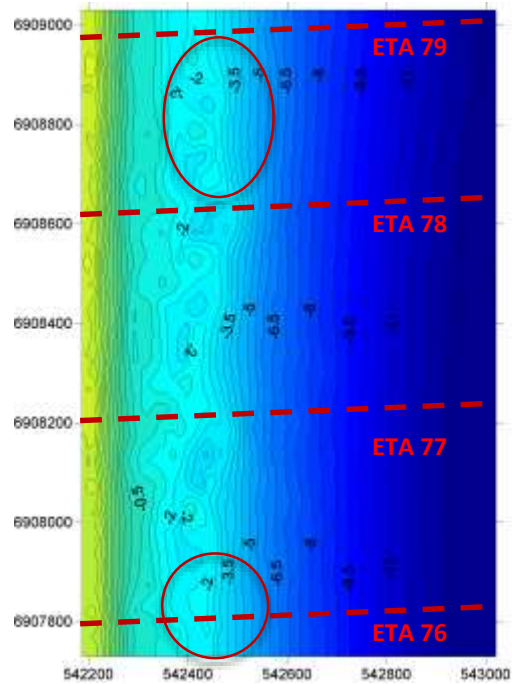

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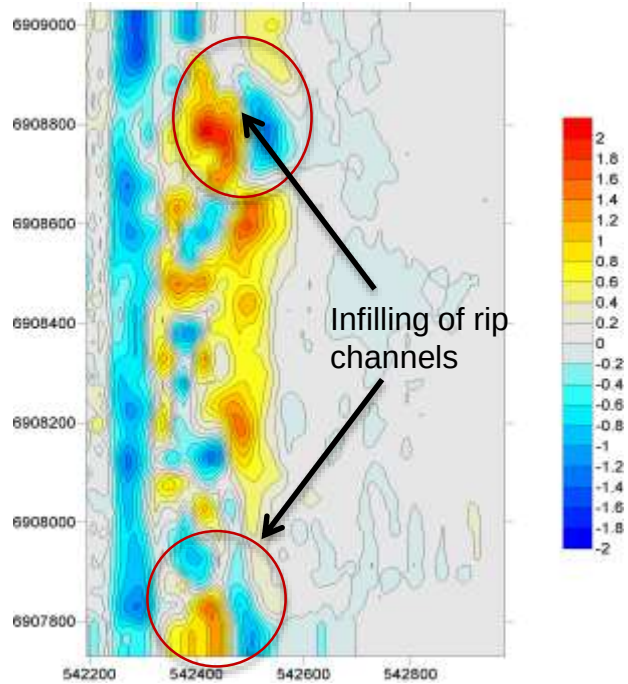


Difference Plot

Coasts?

Land-sea interface

Sediments

- *Fine – mud, sand*
- *Coarse – shell, gravel, stony*

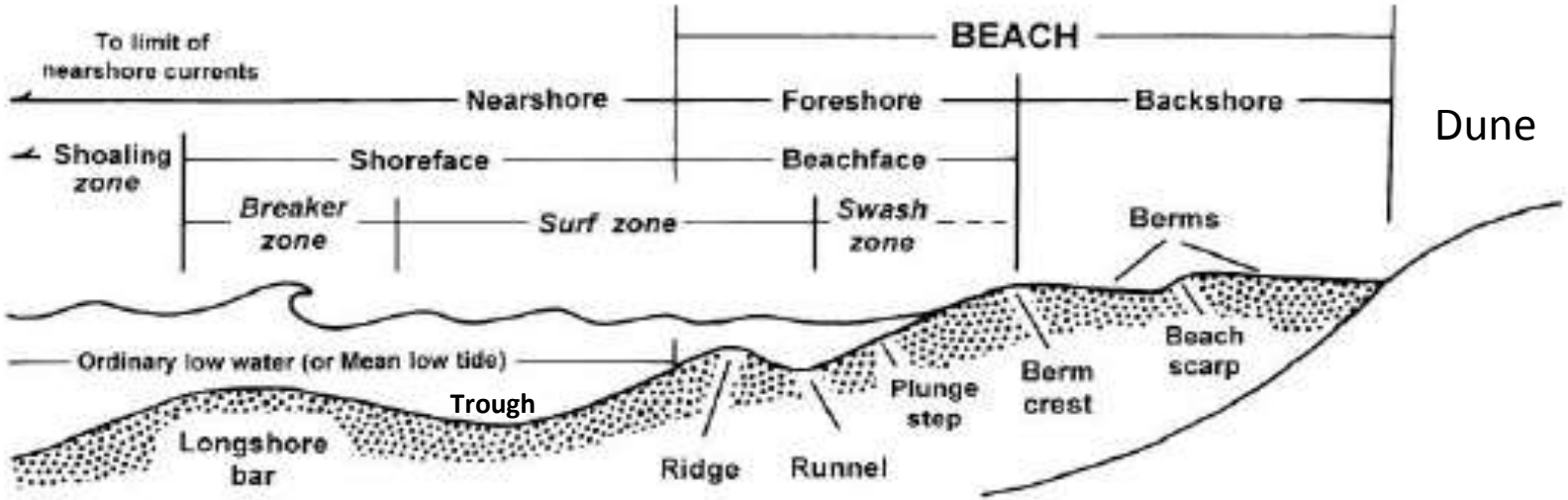
Energy

- *Wind*
- *Waves*
- *Currents*
- *Tides*

Variability

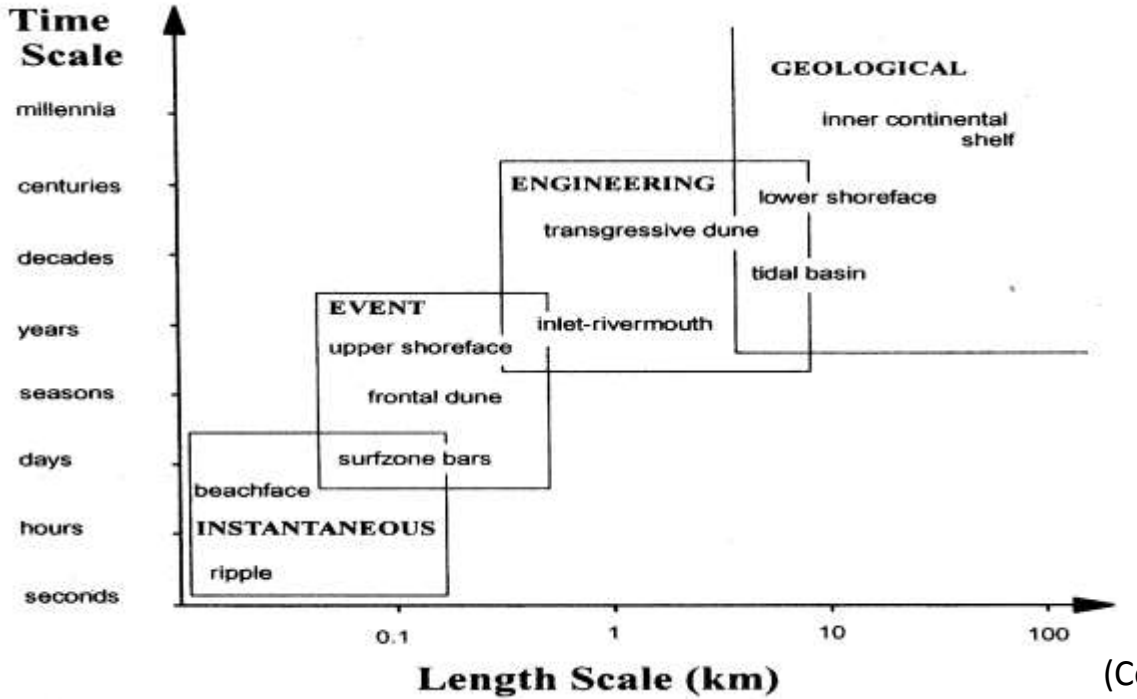
- *Storms*
- *Seasons*
- *Climate Change*

Beach and Nearshore Zone



Schematic view of nearshore zone with corresponding terminology (not to scale) (Schwartz, 2005)

Spatial and Temporal Scales of Coastal Processes and Evolution



Sea level change

Dunes/ridges

Back Barriers/Estuaries

Tidal Inlets/Deltas

Beaches/Storms

Tides/beachface

Individual waves

(Cowell and Thom, 1994)

Australian Beaches – Issues - Impacts

- Early development in erosion prone areas (dune removal)
- Coastal Infrastructure – ports, estuaries, training walls, groynes
- Tourist destinations, accessibility
- Storm periods

  e.g. 1860s-1890s, 1930s, 1950s-1970s
- Major Cyclones, East Coast Lows (QLD)

  1954, 1967, 1972, 1974 2007, *2009, 2013, June 2016, March 2017*

Australian Beaches

10,685 beaches (Short, 2006)

15 beach types: 6 *wave dominated*; 3 *tide modified*; 4 *tide dominated*; 2 rock flats or fringing coral reef beaches.

47% Wave dominated - *High* wave energy, *low* tide range (<2m)

e.g. exposed ocean coasts of WA, SA, Tas, Vic, NSW and SE Qld.

Australian Beaches

10,685 beaches (Short, 2006)

11% Tide modified – *lower* wave energy, *medium* tide range (~2-6m)

e.g. SA gulfs and bays, NW Tasmania, Central Qld

34% Tide dominated – *low* wave energy, *high* tide range (2-11m)

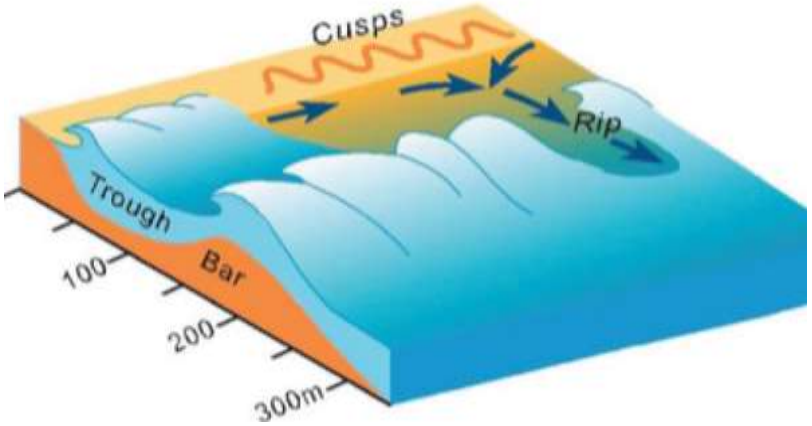
e.g. Northern Australia

Wave Dominated Beaches

e.g. Typical surf beaches of Gold Coast, NSW, VIC, SA, SW WA

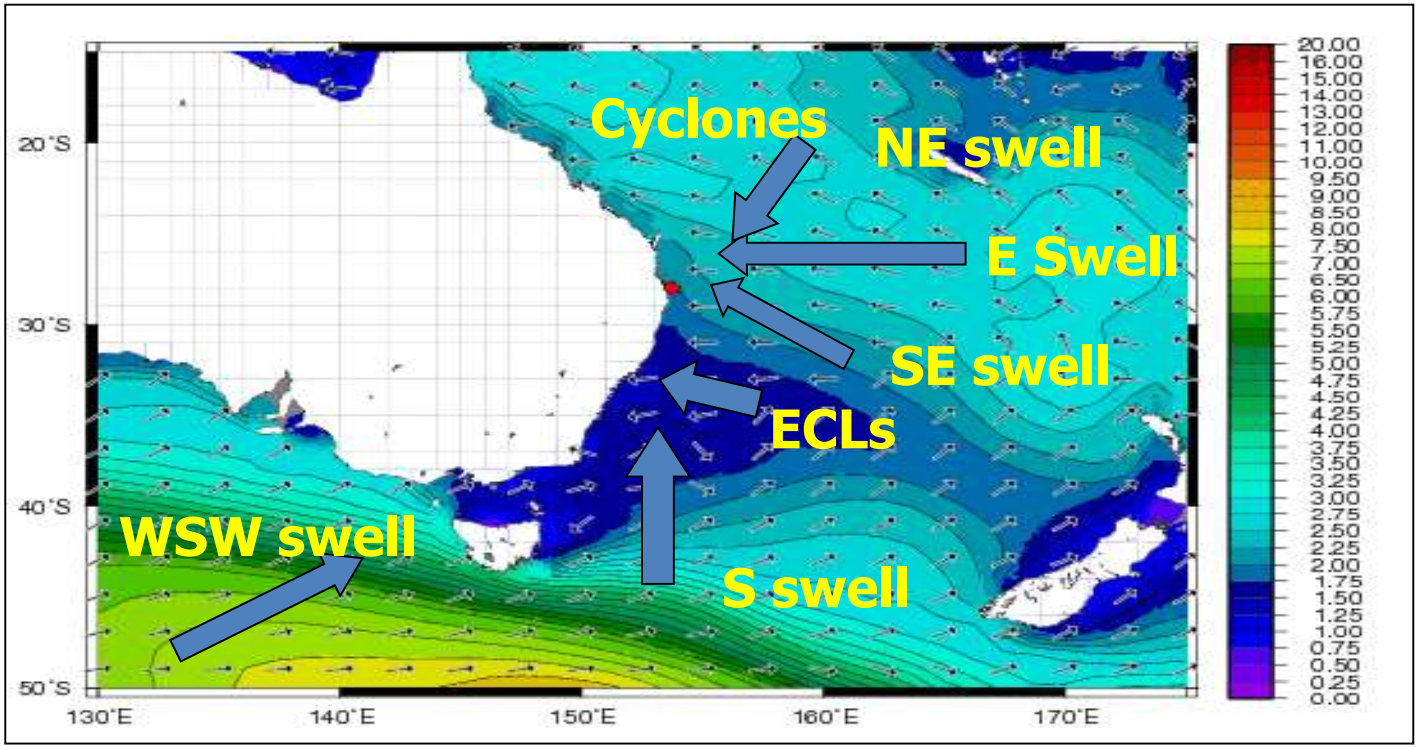
- Beach states further categorised into dissipative, intermediate, reflective (Wright & Short, 1984; Short 1999)

- Intermediate states include:
  - LBT - Longshore Bar & Trough
  - RBB - Rhythmic Bar & Beach
  - TBR - Transverse Bar & Rip
  - LTT – Low Tide Terrace

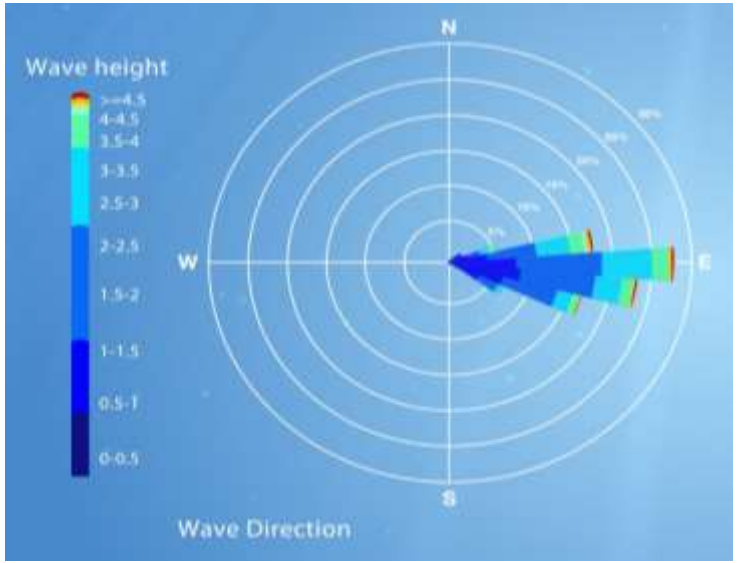


- Swimmer hazards, rip currents, erosion hotspots
- Beach states change with wave conditions and affect resilience

Wave Climate

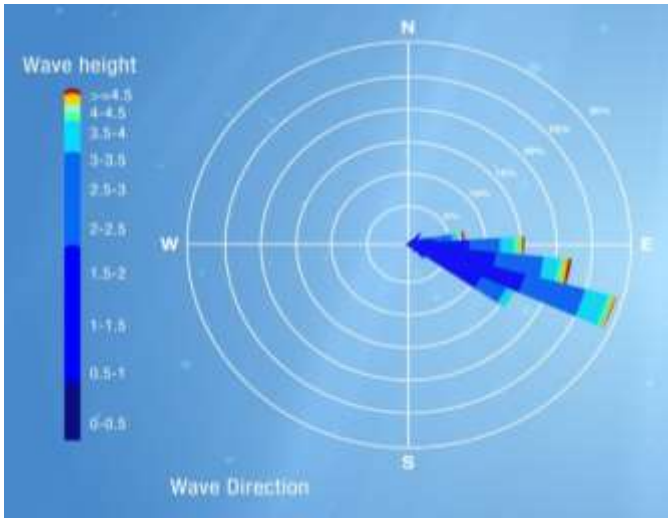


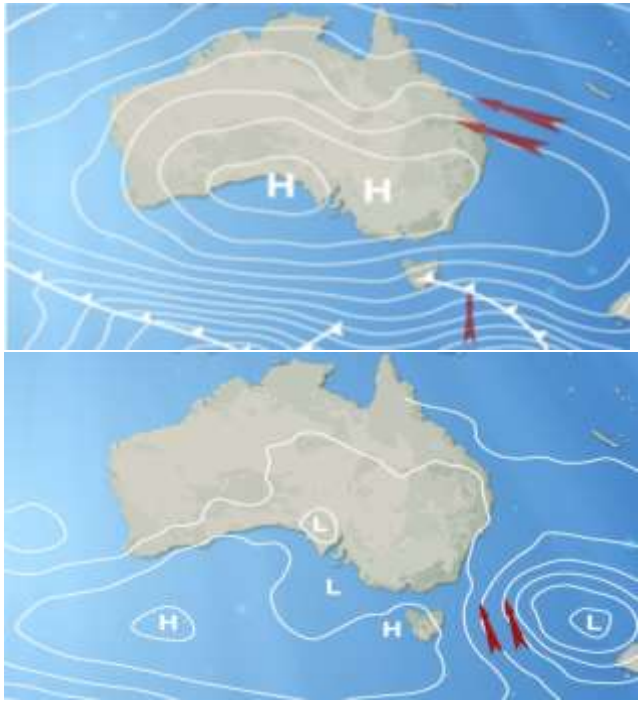
Swell Season – Summer/Autumn (December – May)



- Persistent ESE-SE trade winds & swell in SE QLD
  - energetic, consistent surf
  - Poor windswell and onshore winds in Sth NSW
- Largest waves out of the ENE-ESE (TC's and East Coast Lows)
- Afternoon seabreezes

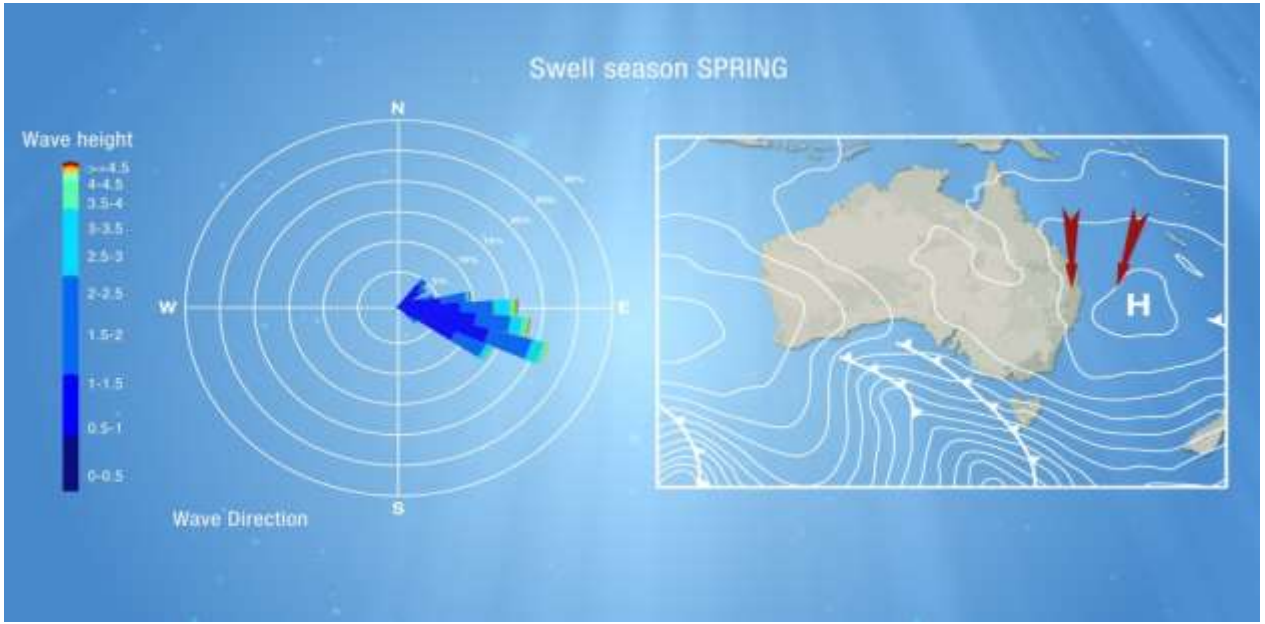
Swell Season – Winter (June – August)





- Highs track north, SE trade winds north of SE QLD
- Decreased wave energy from Summer to Autumn in SE QLD
- Increased likelihood of East Coast Low's affecting East Coast
- Southern Ocean Lows pass from W to E generating south swells that often bypass SE Qld coast
- More offshore winds (SW-NW)

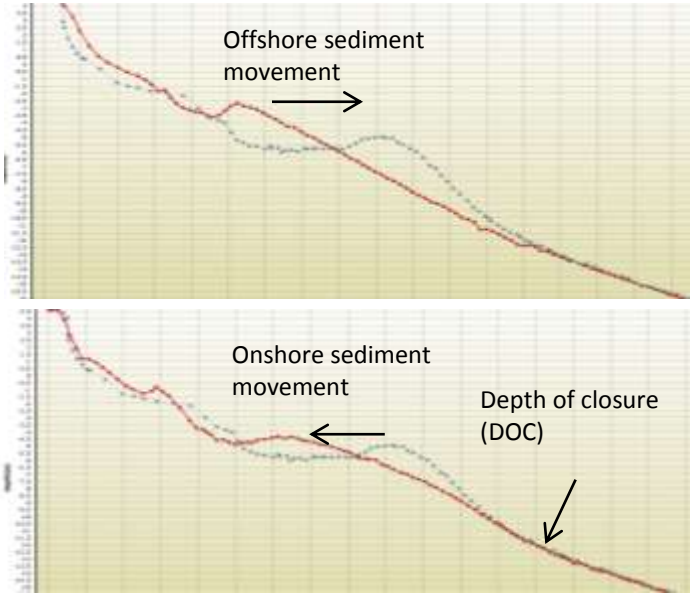
Swell Season – Spring (September – November)

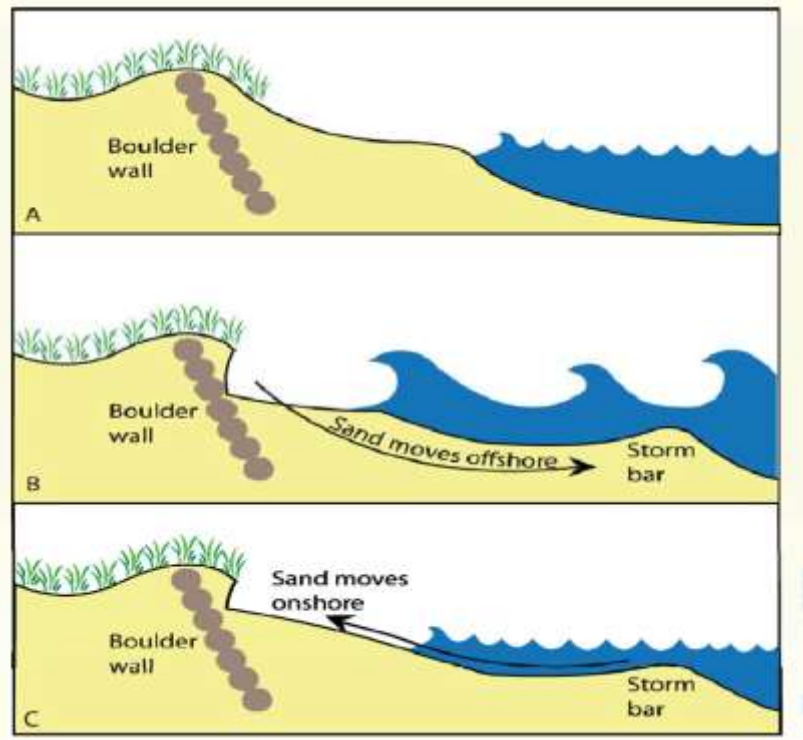


- Typically the smallest wave heights in SE Qld
- Increase in N winds and N-NE windswell
- Dominant SE swell persists (although typically lower energy than other seasons) – SE QLD

Cross shore Sediment Transport

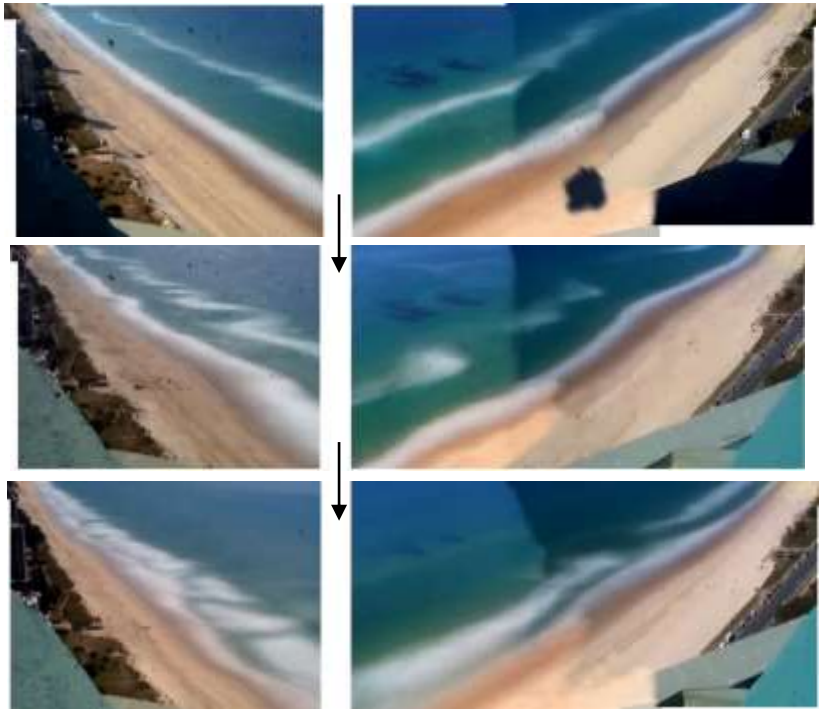
- Storm events, surges, high tides
- Dune scarps
- Storm bar creation / offshore migration
- Beach accretion / onshore migration

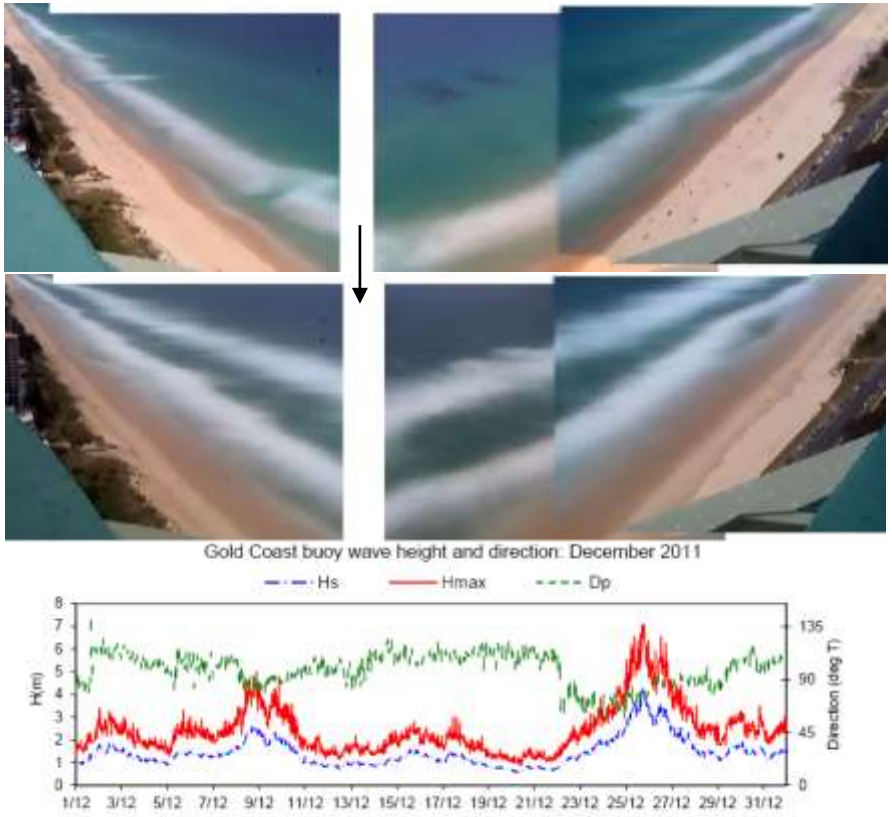




Specks of Sand - Coastal science forum

13th May 2017, University of the Sunshine Coast

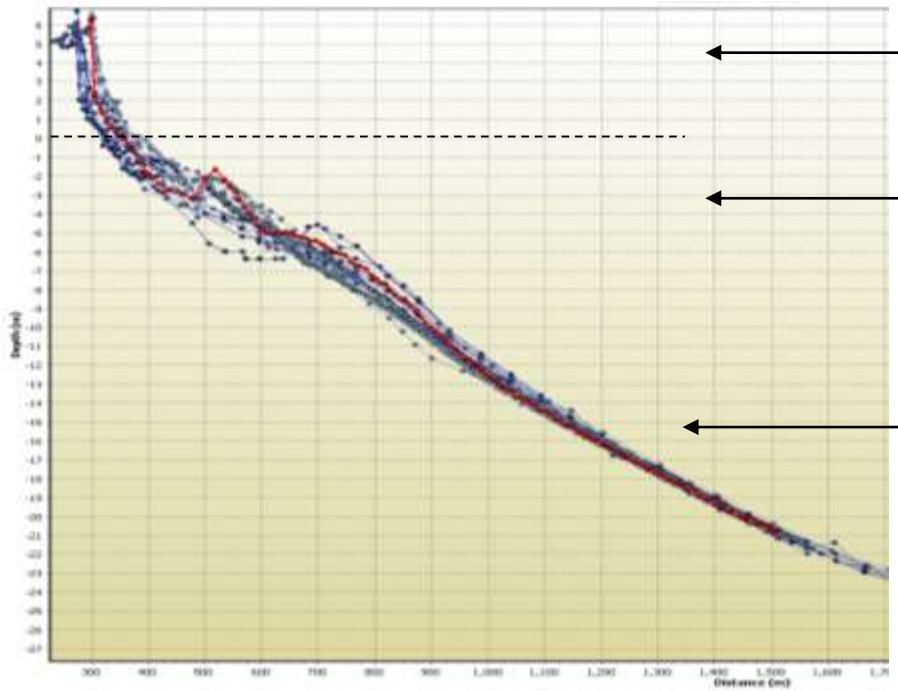




Onshore sand migration / accretion (29/7/2011 – 02/09/2011)

Offshore sand migration / erosion (12/12/2011 – 31/12/2011)

Cross shore Sediment Transport

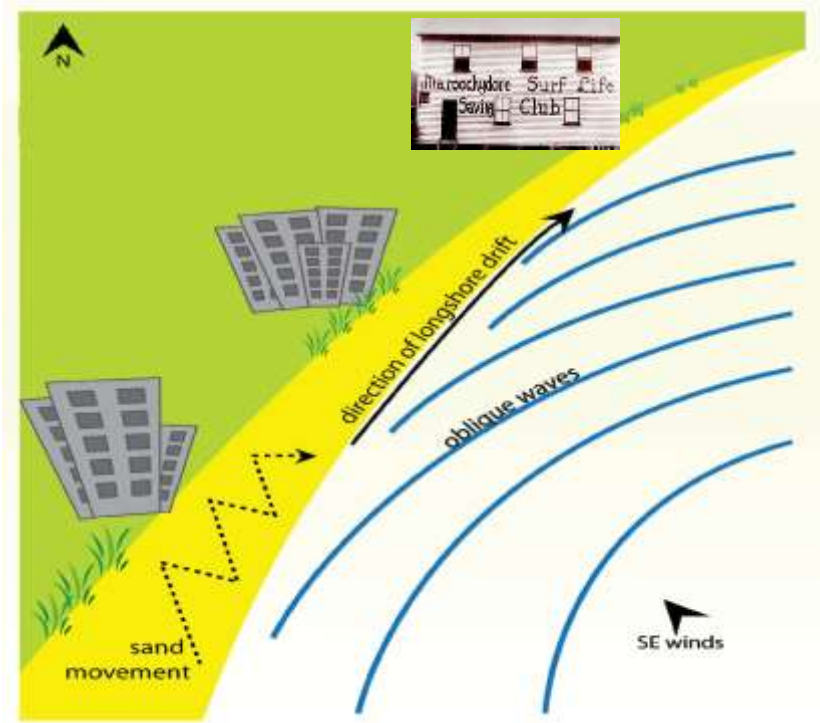


Shoreface zone is less active, but equally significant

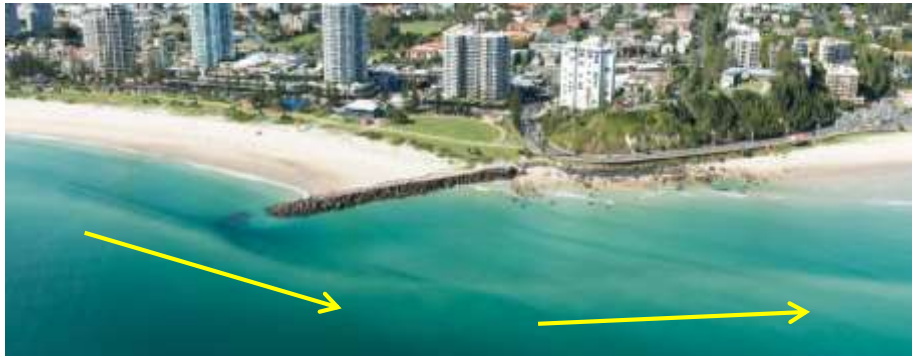
Surf zone (bar zone) is most dynamic

Depth of closure – very minor change

Longshore Sediment Transport



- Littoral drift
- Straight or curved beaches
- Structures, groynes, headlands, reefs



- Trapping and Bypassing

Headland Bypassing

- Oblique wave approach
- Longshore current
- Littoral drift bypassing and entrance infilling

Coastal Monitoring and Data Collection

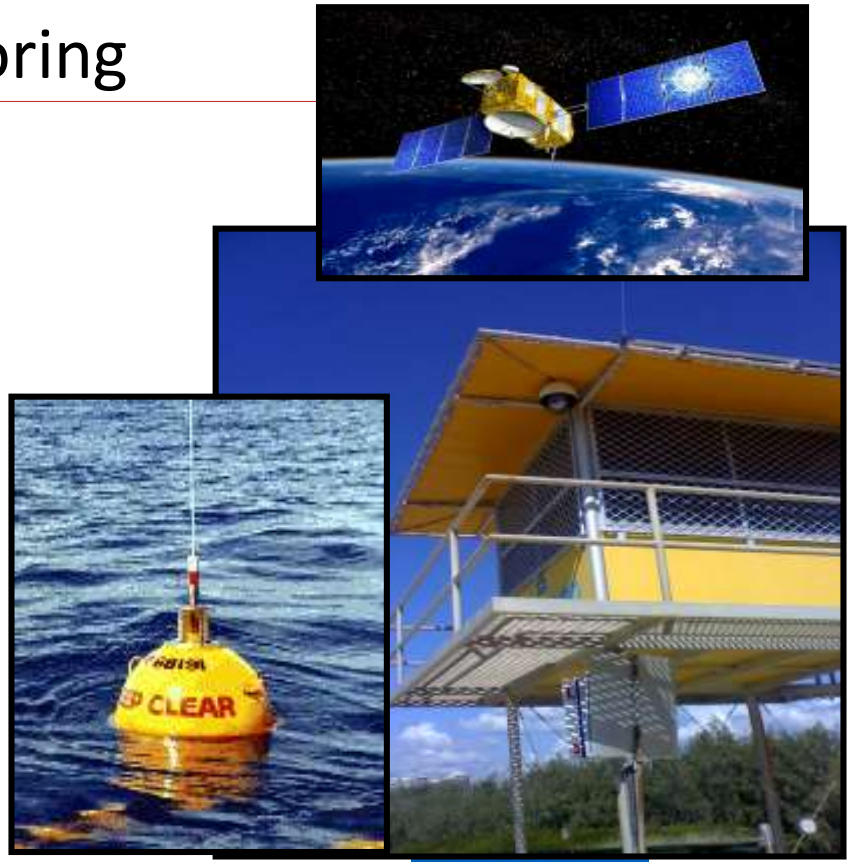
Wave Monitoring

Wave Rider Buoys (DSITI, Qld Govt)

Remote sensing - satellite, video

Pressure gauges

Acoustic Doppler (ADCP)



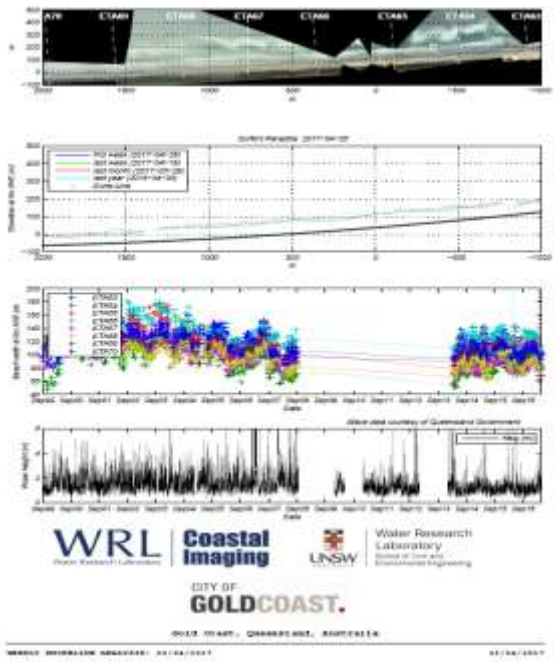
Wave Statistics

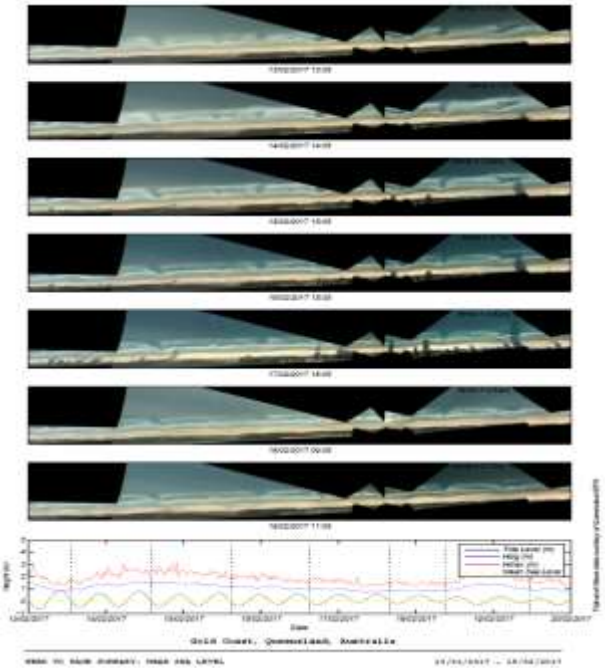
$H_{s,}$ ($H_{1/3}$) Significant Wave Height

T_p, T_m Peak, Mean, Period

Dp, Dm Peak, Mean Direction

Coastal Imaging – Fixed Coastal Camera Networks





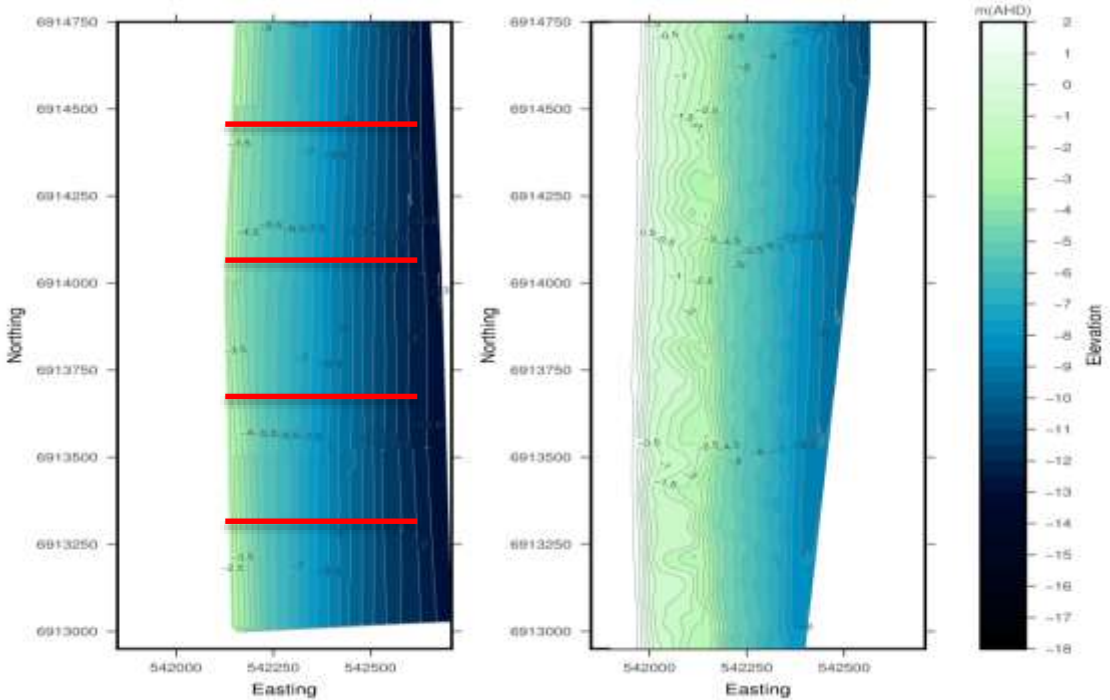
http://ci.wrl.unsw.edu.au/current-projects/northern-gold-coast-narrowneck-reef/

Coastal and Nearshore Survey

- **Traditional Survey Methods:** Emery method (onshore), Theodolite & staff (surf zone), Boats (offshore)

- **Modern Survey Methods:** DGPS, RTK-GPS, PWC (surf zone), Terrestrial and Marine Lidar, Multibeam, Drones!

Survey methods

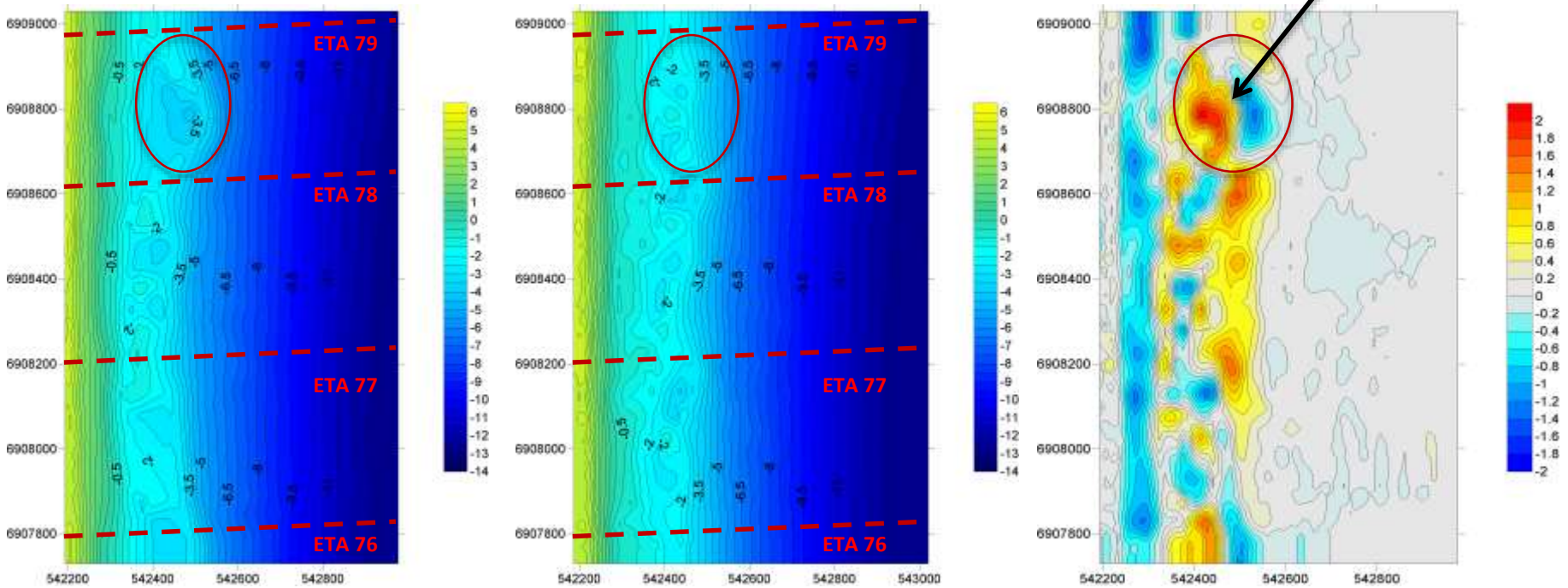


Increased resolution in space and time

e.g. 400 m spacing vs 50 m spacing

Griffith UNIVERSITY

High spatial frequency survey (jetski and land based RTK)



3/2/2016

3/4/2016

Difference Plot

Drones (UAVs)

Debris line Mackay – Cyclone Debbie March 2017

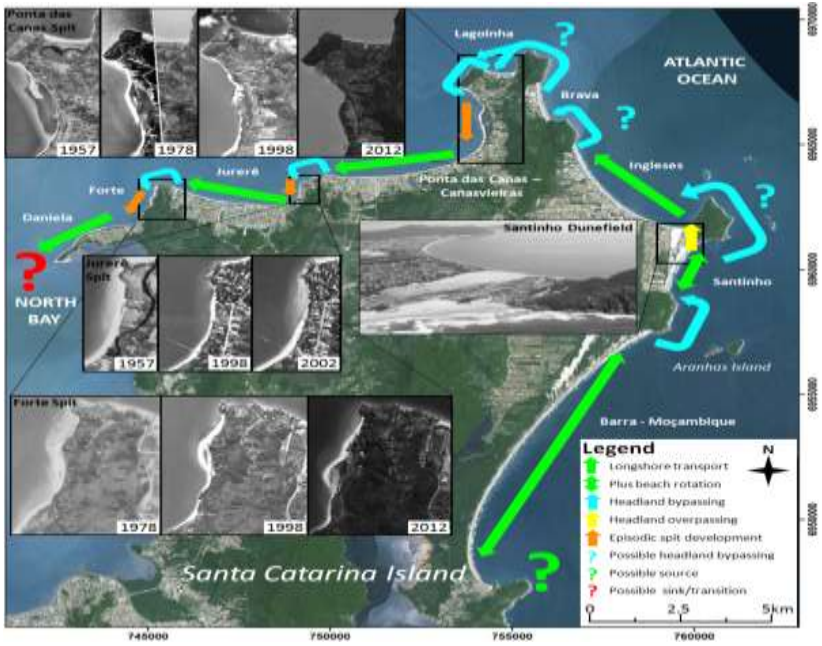
- Data used to calibrate storm surge models (Qsurge)

Tanna Island – Vanuatu 2017

- Drone imagery to develop Point cloud survey for coastal resilience study

Longshore sediment transport and headland bypassing

- Traditional Surveying
- Current Meters
- Sediment Traps
- Sediment Tracer
- Turbidity Loggers

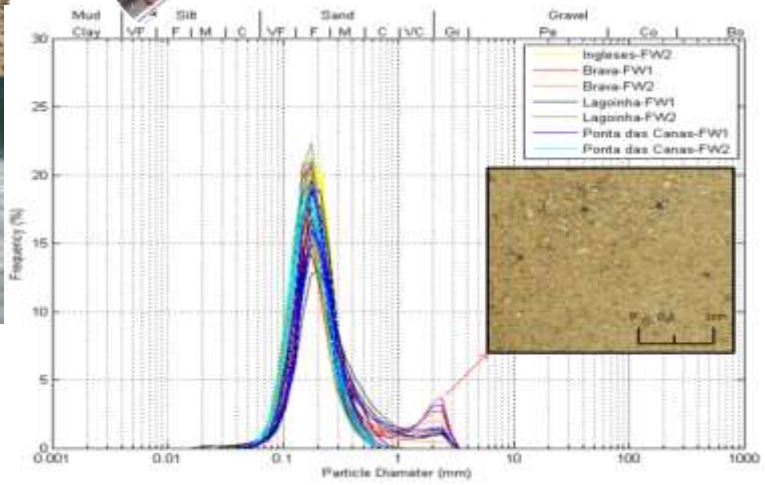


Santa Catarina Island, Brazil

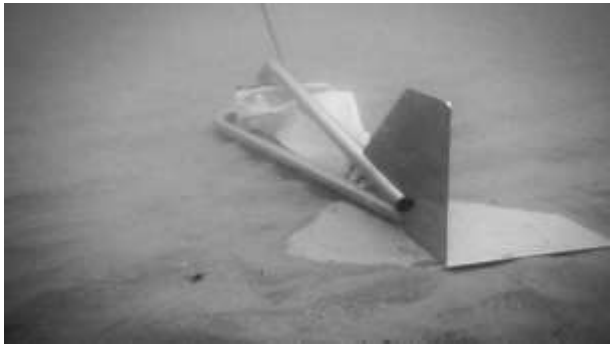
Sediment Transport and Grain size Characteristics

Fluorescent sediment tracers

Turbidity Logger – converts turbidity into suspended sediment concentration



Grain size distribution from a particle analyser

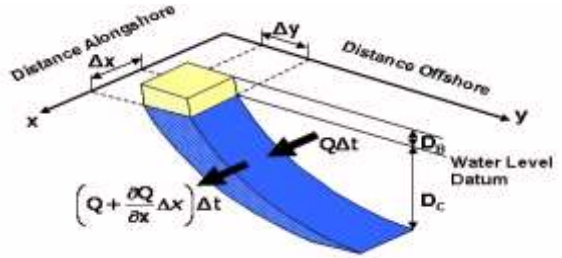


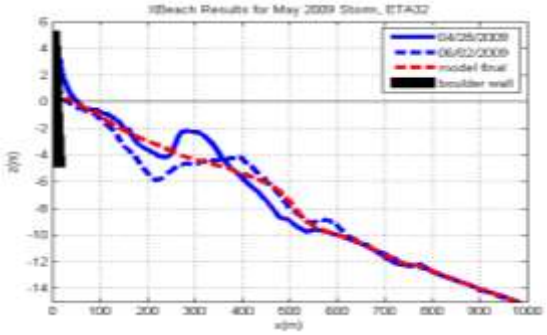
Helley-Smith Sediment Sampler – sediment transport / headland bypassing

Physical process based models

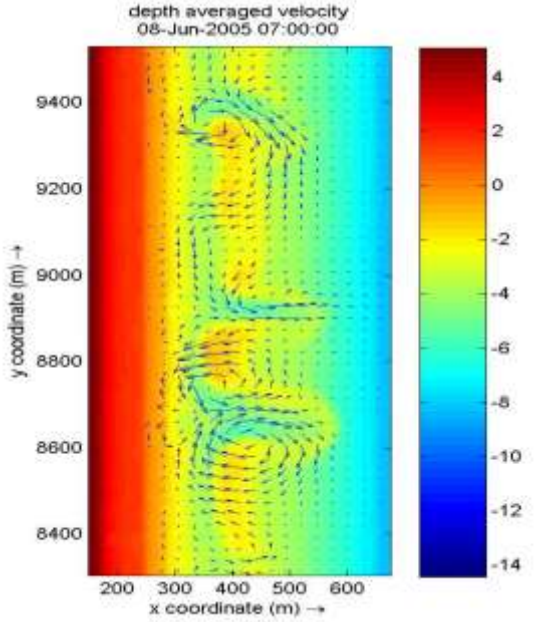
Inform decision making & management strategies

Longshore (shoreline)





Cross-shore (storm cut)
e.g. Sbeach, EVO



2D/3D process
e.g. DELFT3D, Mike 21, XBeach


Thank you!