Modelling of the Bribie Island Breakthrough

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Agenda

1. **Bribie Island Overview:** Brief introduction and historical context

2. **The Breakthrough:** Summary and impacts

3. **Project Scope:** Defining the project that lead to this modelling

4. **Modelling**
   - Model setup
   - Hydrodynamics: Impacts of the breakthrough on hydrodynamics
   - Morphology: Setup, calibration, scenarios

Photo courtesy of Allan Harford

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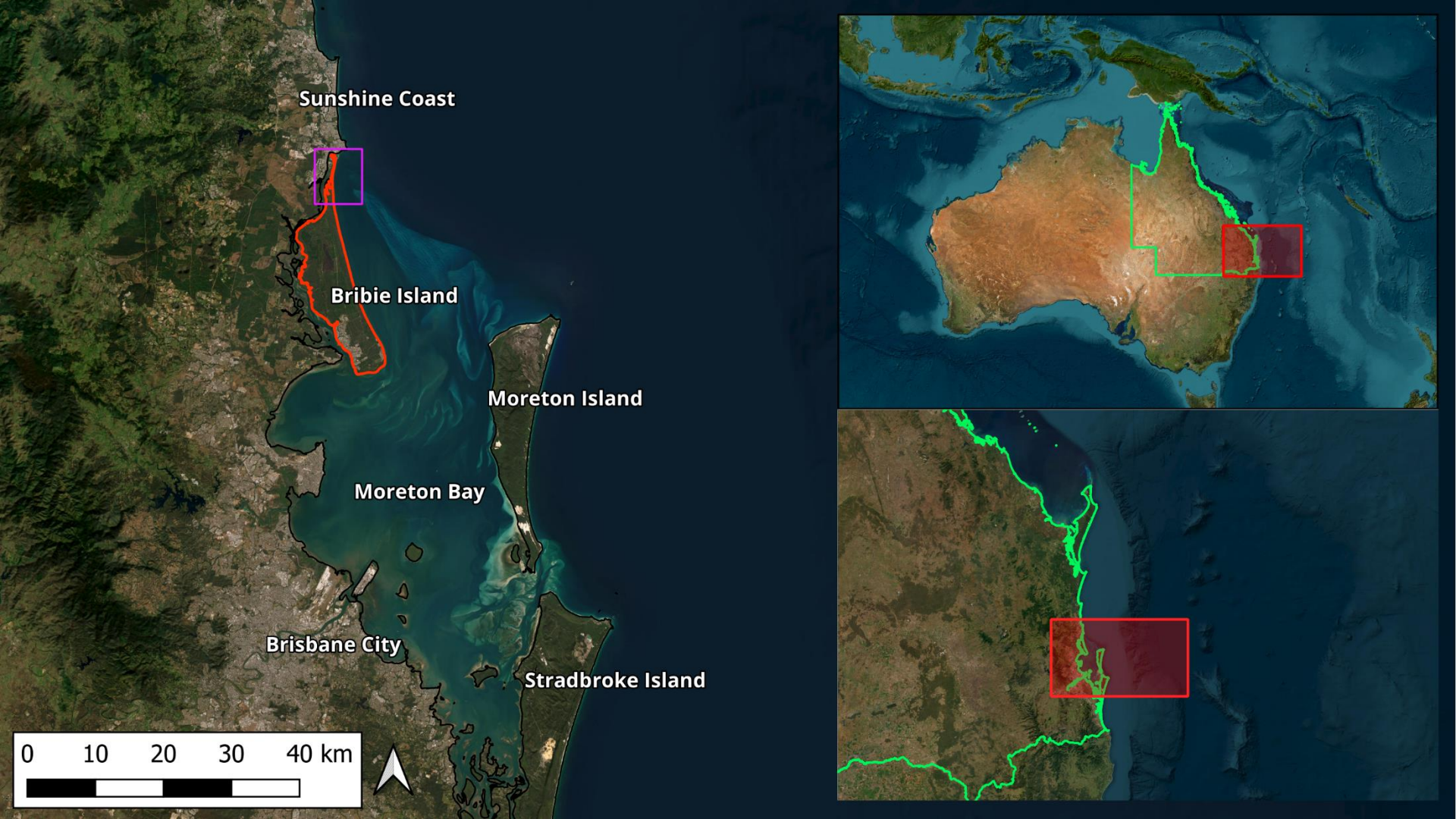
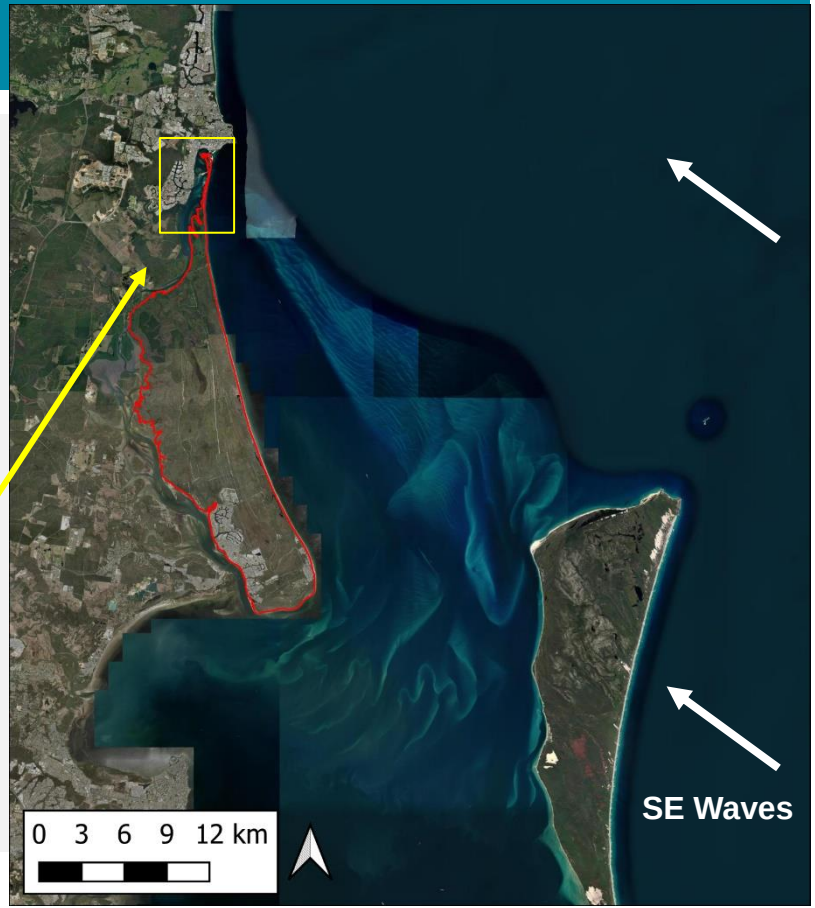
Why are we doing this?

- **2022 Breakthrough:** Bribie Island experienced a breakthrough, blocking northern navigation access
- **Community concerns:** Strong appeals to restore this access
- **Our Role:** We're investigating the feasibility of using dredging to reinstate navigation
- **Modelling**
  - Hydrodynamics: Impacts of the breakthrough
  - Morphology: Assessing sedimentation to directly address the main concern – feasibility


Sunshine Coast
Bribie Island
Moreton Island
Moreton Bay
Brisbane City
Stradbroke Island
0
10
20
30
40 km

Bribie Island

- Bribie Island is a detached sand barrier island from the mainland.
- It is 34 km long and 8 km at its widest.
- History of erosion incl. shoreline recession and net southerly longshore transport.
- **Our focus today is on the northern end of the island.**



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Caloundra
Golden Beach
Caloundra Bar
Pumicestone Passage
0 0.5 1 1.5 2 km


Caloundra
Golden Beach
Caloundra Bar
Bribie Bar
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0 0.5 1 1.5 2 km

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Northern Bribie Island and the Breakthrough

- **Sand transport:** indications of a transition point, hinting at prolonged sand volume loss
- **Jan 2022:** Ex. Tropical Cyclone Seth eroded dune height below the tidal level
- **Immediate Aftermath:** Tidal action quickly formed a channel, growing to 150m wide in just days.
- **One Year On:** Entrance “stabilised” ~1km wide, with a 150m deep channel to the north.

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Impacts to Navigational Access

- **Dynamic System:** Bribie Bar is now a highly dynamic entrance system
- **Obstruction:** A vast sand shoal has formed, blocking the historic north-south navigational channel in Pumicestone Passage.
- **Access Blocked:** No navigation possible north of the breakthrough, prompting requests to Maritime Safety Queensland for restoration.

The Project

- **Our Role:** BMT tasked with modelling both pre and post impacts and evaluating intervention solutions

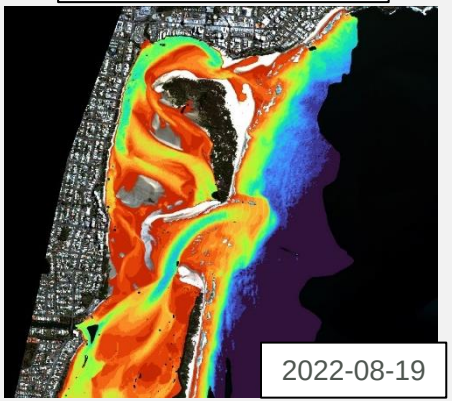
- **Hydrodynamic Impacts:**
  - Develop a fit-for purpose model
  - Assess hydrodynamic impacts (water-levels, currents, tidal prism, wave penetration)

- **Morphological Modelling:**
  - Conduct sediment transport modelling to directly evaluate intervention strategies

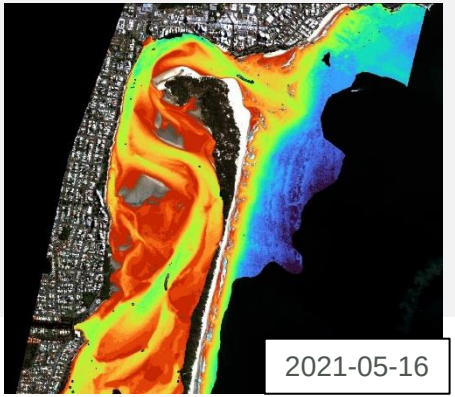
Data - Satellite Derived Bathymetry

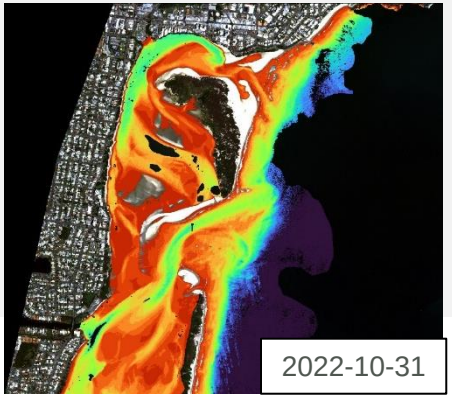
- Client procured satellite derived bathymetry, both pre and post breakthrough
- The datasets compared well with surveys for areas less than 8m deep
- The post-breakthrough datasets were foundation for morphological calibration

Post breakthrough



Pre breakthrough





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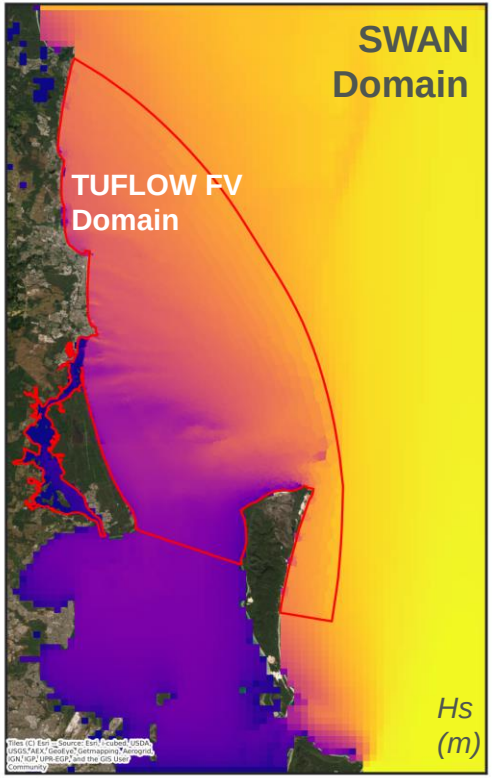
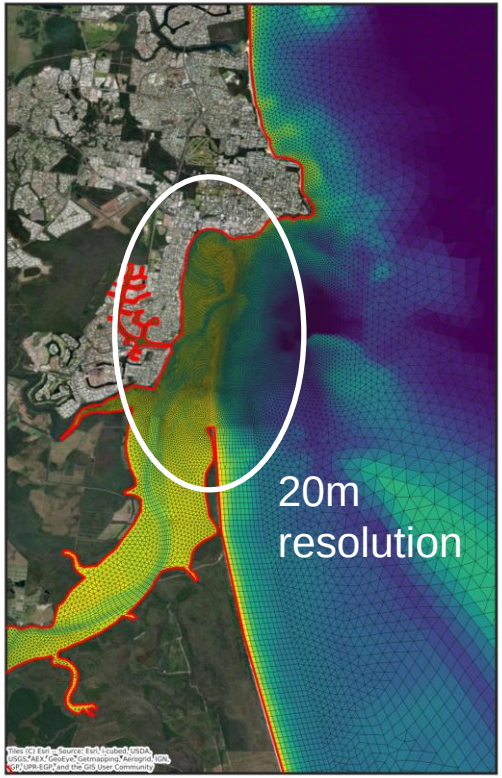
Model Configuration

- **Resolution:** Mesh cells approximately 20m around breakthrough area
- **Coupling:** Used SWAN wave models to drive longshore currents
- **Key Configuration:**
  - Variable bed friction
  - 2nd order
  - 2D Model
- **Simulation Period:** 1 – 6 months





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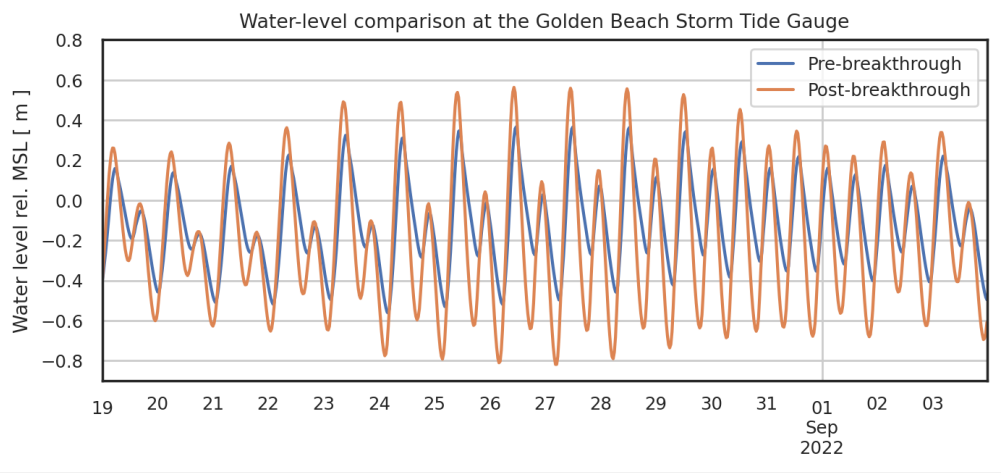
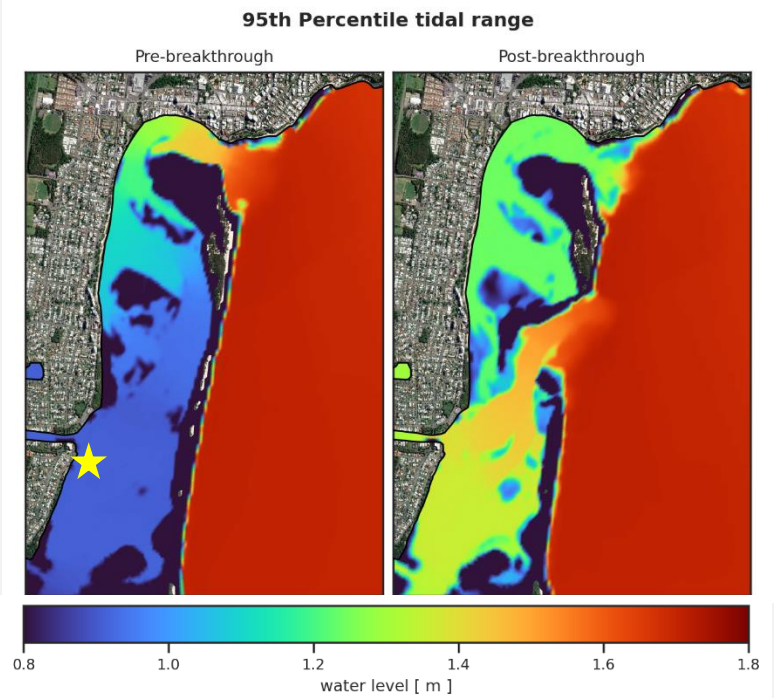
Hydrodynamics: Change in Tidal Range

Notable increase in tidal range post breakthrough (+ 40 – 55%)



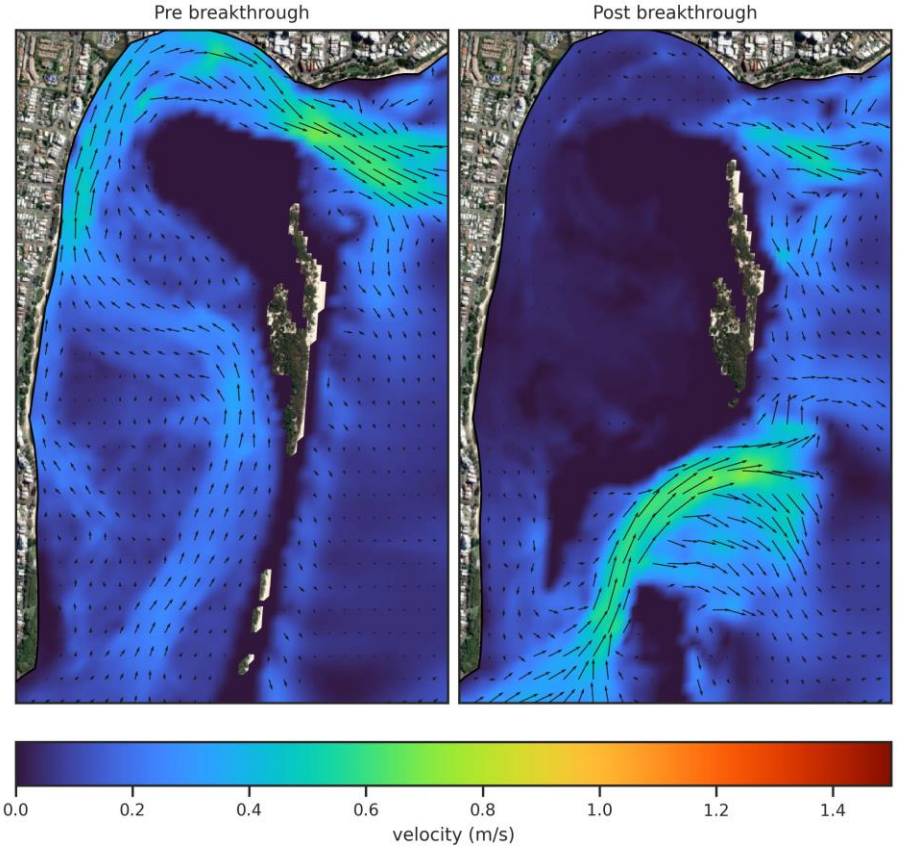


Hydrodynamics: Currents

Changes to Currents

- **Caloundra Bar:**
  - Previously ebb tide dominated
  - Post-breakthrough flood tide dominance

- **Bribie Bar:**
  - Ebbing tide stronger than the flooding tide (Ebb tide dominance)

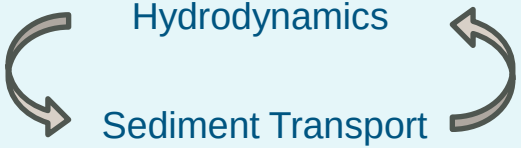


Sediment Transport Module Setup

- **Core Model:** TUFLOW Sediment Transport Module with coupled morphology enabled.
- **Sediment Transport Model:** van Rijn et al (2004)'s TRANSPOR2004 model
  - Chosen based on success with previous dynamic mouth entrances on the Sunshine Coast
- **Parameterisation:** Adjustable parameters allow fine tuning between current- and wave-driven transport efficiency
- **Sediment Fractions:** Single sand fraction with median grain diameter (d50) 0.2mm

Coupled Morphology

Bathymetry = *f*(hydrodynamics, sediment transport)



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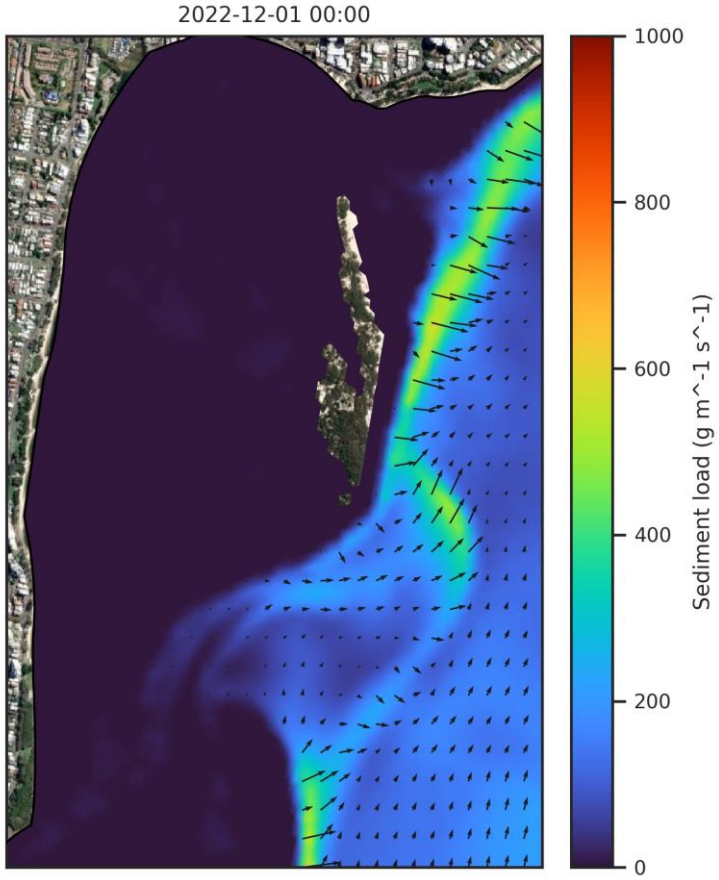
Sediment Transport Processes

- **Tidal Transport:**
  Net ebb-tidal transport, with flood-tide transport influencing shoal dynamics
- **Cross-shore Wave Transport:**
  Typical modal conditions promote onshore sediment transport; while storms drive sand offshore.
- **Longshore Transport:**
  Breaking wave action will move sediment up or down coast



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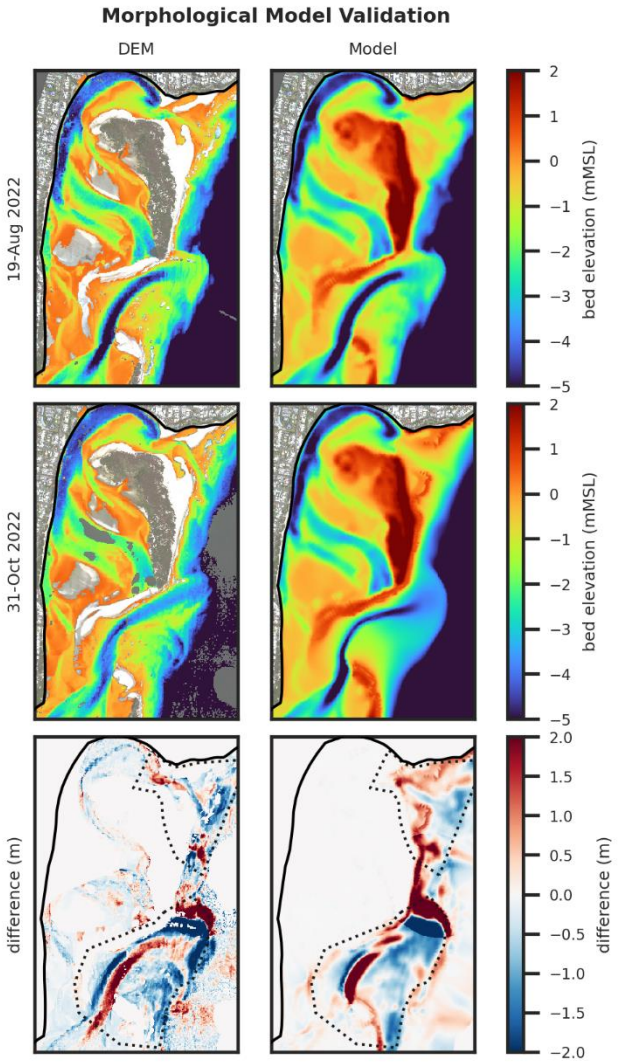
Morphological Calibration

- Calibration utilised satellite derived bathymetry from 31 Oct ’22
- Morphological evolution was calibrated quantitatively using model metrics
- Model captured key morphological processes well:
  - Ebb shoal growth
  - Onshore sand migration
  - Flood shoal formation



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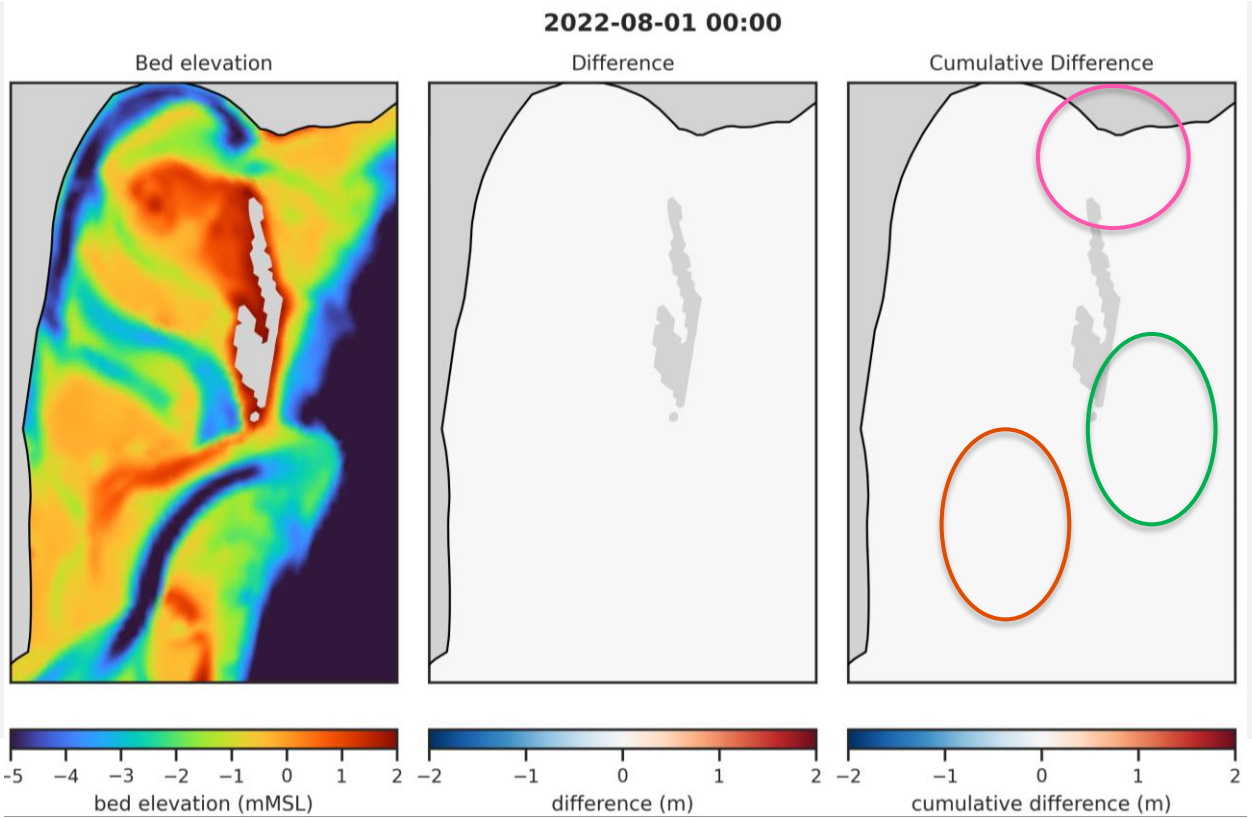
Morphological Evolution

1. Ebb shoal growth

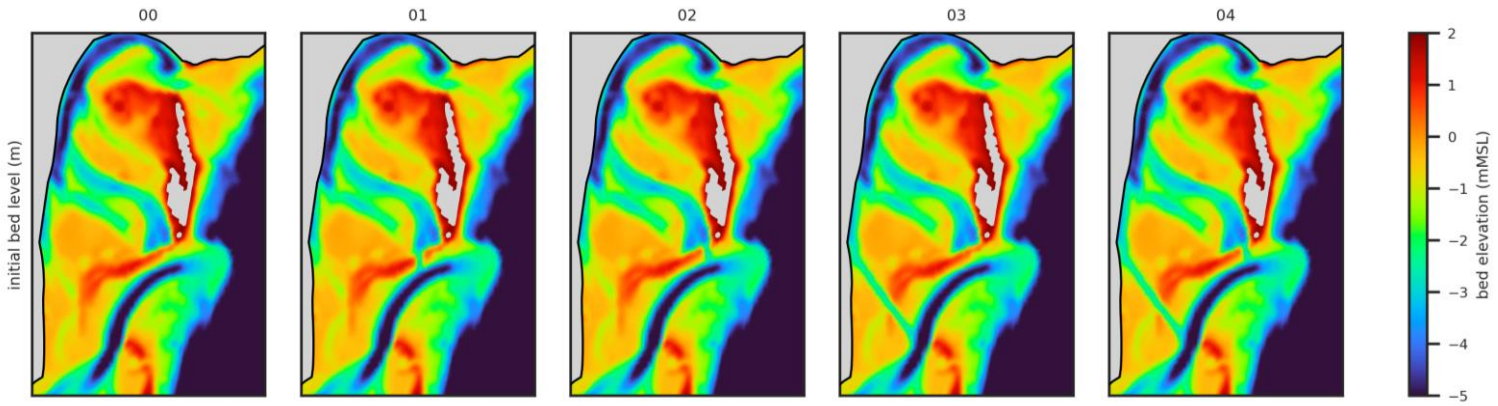
2. Onshore sand migration

3. Flood shoal formation



Morphological Model Scenarios

- Investigated several channel layouts
- 6-month simulations periods from Aug 22’ to Feb 23’
- Channels had a depth of 3m LAT and included dredge batters
- Included sensitivity scenarios covering a different 6-month period (Feb 22’ to Aug 22’, featuring stronger wave energy climate)



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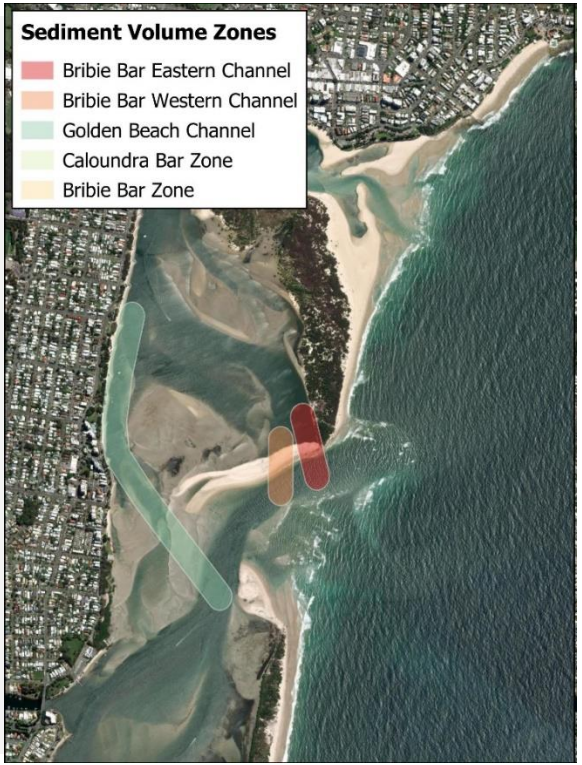
Morphological Model Results

- Channel construction scenarios increase the rate of infilling of the Caloundra Bar entrance
- Constructed channels would have a high risk of infilling
- Timescale of infilling is measured in weeks to months

Channel scenario sedimentation predictions

Channel Location	Dredge Volume (m^3)	Sedimentation (6 months)
Bribie Bar East / West	17,000	Up to 57%
Golden Beach	77,200	Up to 49%



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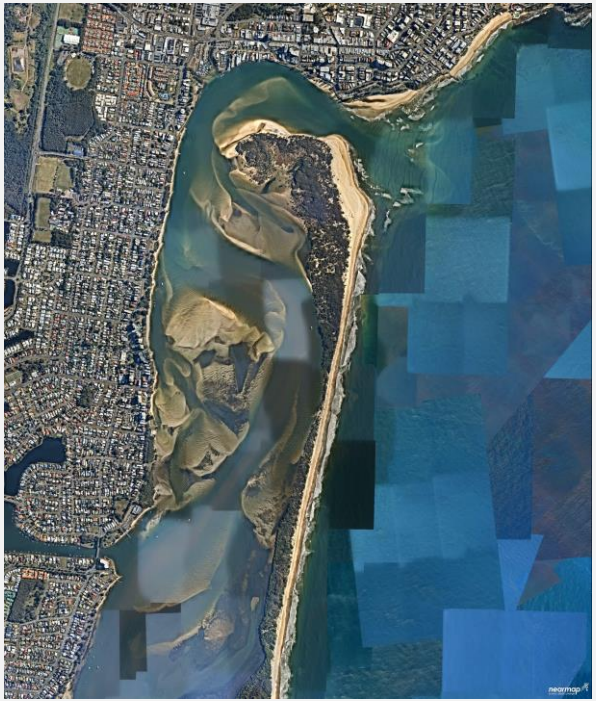
Recap and Recent Developments

- The Bribie Island breakthrough caused swift alterations to northern Pumicestone Passage
- This project was undertaken in late 2022 to early 2023; during which the area experienced continual change.
- A year after, the sand shoal naturally broke through, restoring navigation.
- While the channel remains highly dynamic, this addresses immediate navigation concerns.



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Thank-you

Photo courtesy of Allan Harford

Questions?