MODELLING PORT FAIRY

Predicting compartment-scale climate change impacts related to Southern Ocean wave forcing

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THE INTRODUCTION

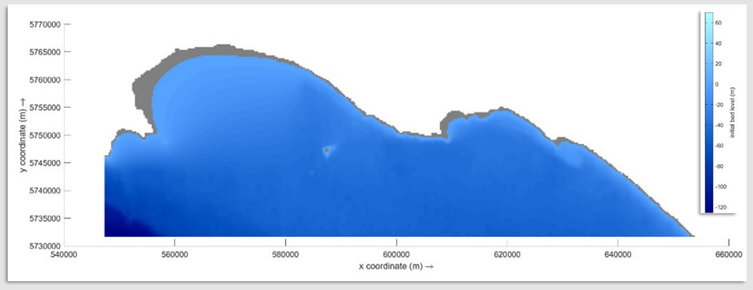
A **change in wave intensity and direction resulting from climate change** is likely to cause significant changes in sediment dynamics and possible shoreline reorientation in sediment compartments. This theory is being tested using numerical modelling techniques at Port Fairy Bay. The **Delft3D FLOW-WAVE** modules are used to explore the sensitivity of this bay to changes in the wave direction.

This project is part of the **Victorian Coastal Monitoring Program (VCMP)** that was formed to address community concerns of present and future coastal risks. A key component is coastal compartment modelling and visualization, which is being used to understand and predict the future shoreline morphodynamics.

THE METHODS

Three model domains were constructed: (a) a coarse Delft3D-FLOW model covering the area between Portland and Port Campbell, and a nested finer model consisting of a coupled (b) Delft3D-FLOW and (c) Delft3D-WAVE model that are setup with distinct domains and input files but which execute sequentially at defined time intervals and share output data via a communication file. All models are run for a duration of 1 month.

a) Coarse Delft3D-FLOW model

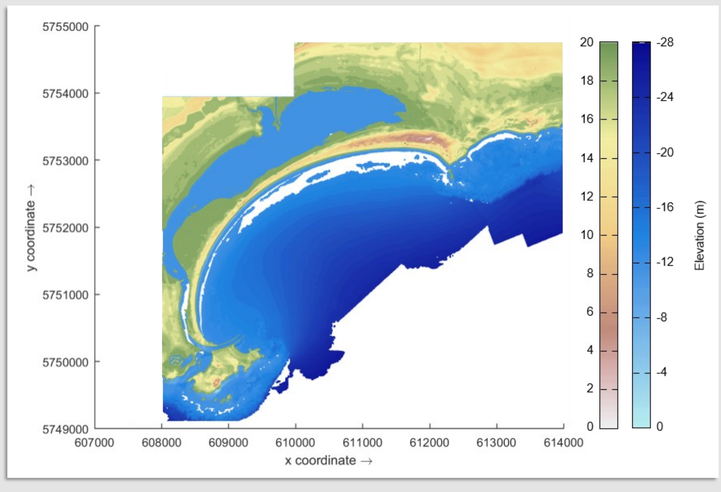


Resolution: 250 m, covering an area of approximately 107 km between Portland in the west and Port Campbell in the east and extends offshore by approximately 35 km

Bathymetry: Geoscience Australia 'Australian Bathymetry and Topography Grid' dataset

Hydrodynamics: TPXO 7.2 Global Inverse Tide Model

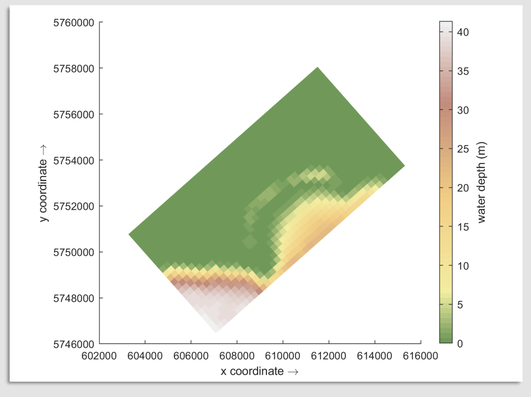
(b) Nested, Finer Delft3D-FLOW model



The finer FLOW domain (b) is nested within the coarser grid (a) and online-coupled to the WAVE domain (c). Coupling between the fine FLOW and WAVE domain occurs every 60 minutes.

Resolution: 25x25 m offshore to 25x15 m resolution at the shoreline
Bathymetry: VICMAP Elevation dataset
Sediment: D50 VCMP dataset
Wind: BoM twice daily
Hydrodynamics: Derived from the coarse FLOW and WAVE model.

c) Coupled Delft3D WAVE model



Resolution: 250 m
Bathymetry: Geoscience Australia
Hydrodynamics: spectra from Port Fairy Wave Buoy

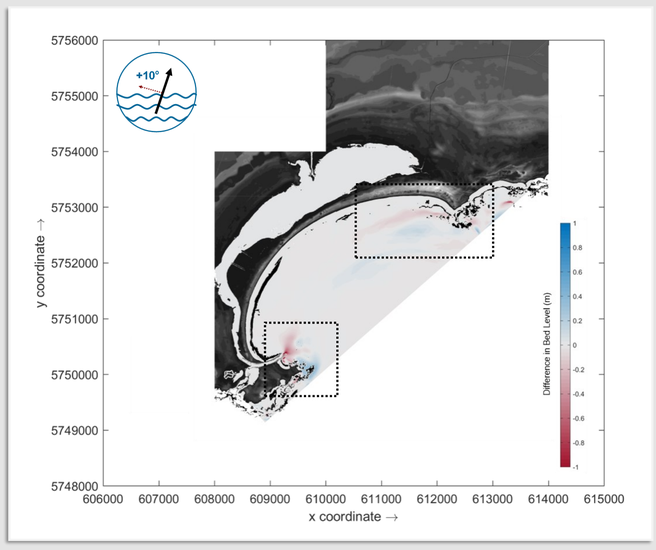
THE RESULTS

Bed Level Change

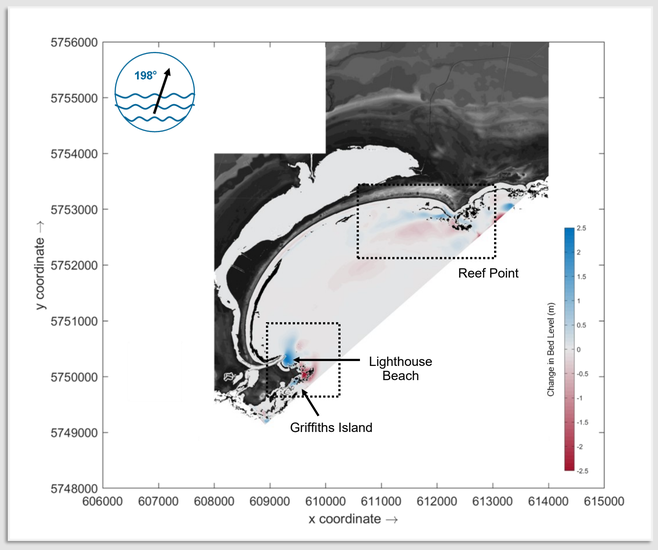
A significant change in modelled bed elevation occurs 9/10/2018 at Griffiths Island and at Lighthouse Beach on 10/10/18, coincident with the highest wind speed in October 2018.

Bed level change observed at Griffiths Island correlates with:

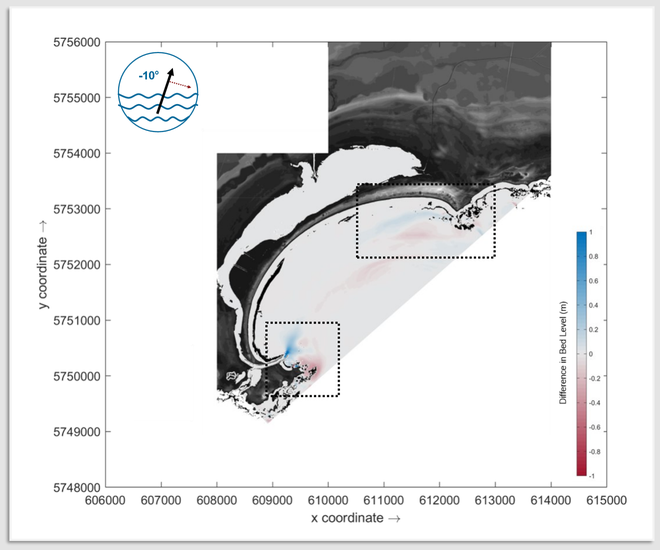
- Bed Level Change at Lighthouse Beach (-0.87)
- Significant wave height (0.73)
- Mean wave direction (0.60)



A more westerly wave climate **(+10°) lessens** bed level change relative to simulations driven by normal wave conditions.



Hotspots are consistently found around the extremities of the bay, (Griffiths Island and Reef Point) and along the central shoreline.



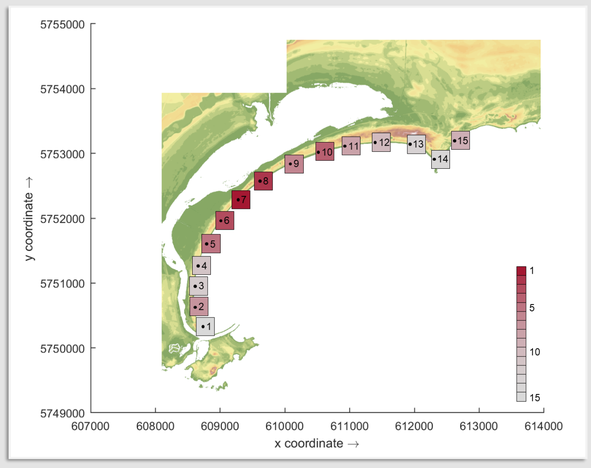
A more southerly wave climate **(-10°) intensifies** bed level changes relative to simulations driven by normal wave conditions.

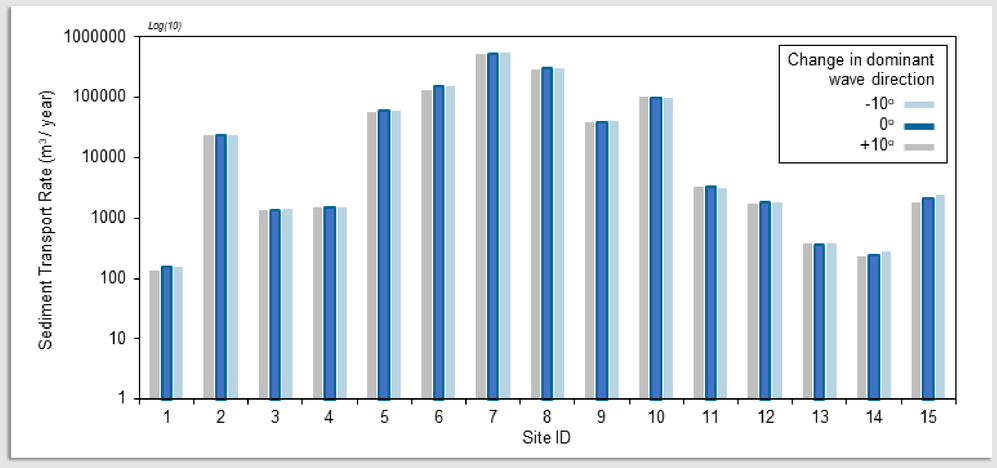
Sediment Transport Rates

Spatial variations in sediment transport rates in Port Fairy under changing wave directions, are consistent with patterns found under normal wave conditions. Each of the **15 sites rank identically under the baseline model and under ±10° wave direction scenarios**.

A **negative** rotation in the wave climate (southerly) results in an **increase in sediment transport rates at 66% of the sites** relative the baseline, not limited to the central shoreline but occurring along it's length.

It is also found that a **negative** rotation leads to greater rates of transport at **87%** of the sites, compared to a **positive** rotation.





THE CONCLUSION

Under current projections, the southern coast of Australia is expected to experience a more southerly wave climate due to changes in the location of the Southern Ocean storm systems.

Climate driven changes in the dominant wave direction in Port Fairy bay could alter the magnitude of sediment transport processes that in turn, influence sedimentation and erosion patterns .

A negative rotation of the baseline wave climate, increased sediment transport rates along a high percentage of the shoreline and enhances hotspots of erosion and sedimentation across the bay.

A positive rotation in the wave approach reduces the intensity of bed lowering or shallowing in Port Fairy bay, although the pattern of change remains consistent relative to normal wave conditions.

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