The Bureau of Meteorology

Australian Government

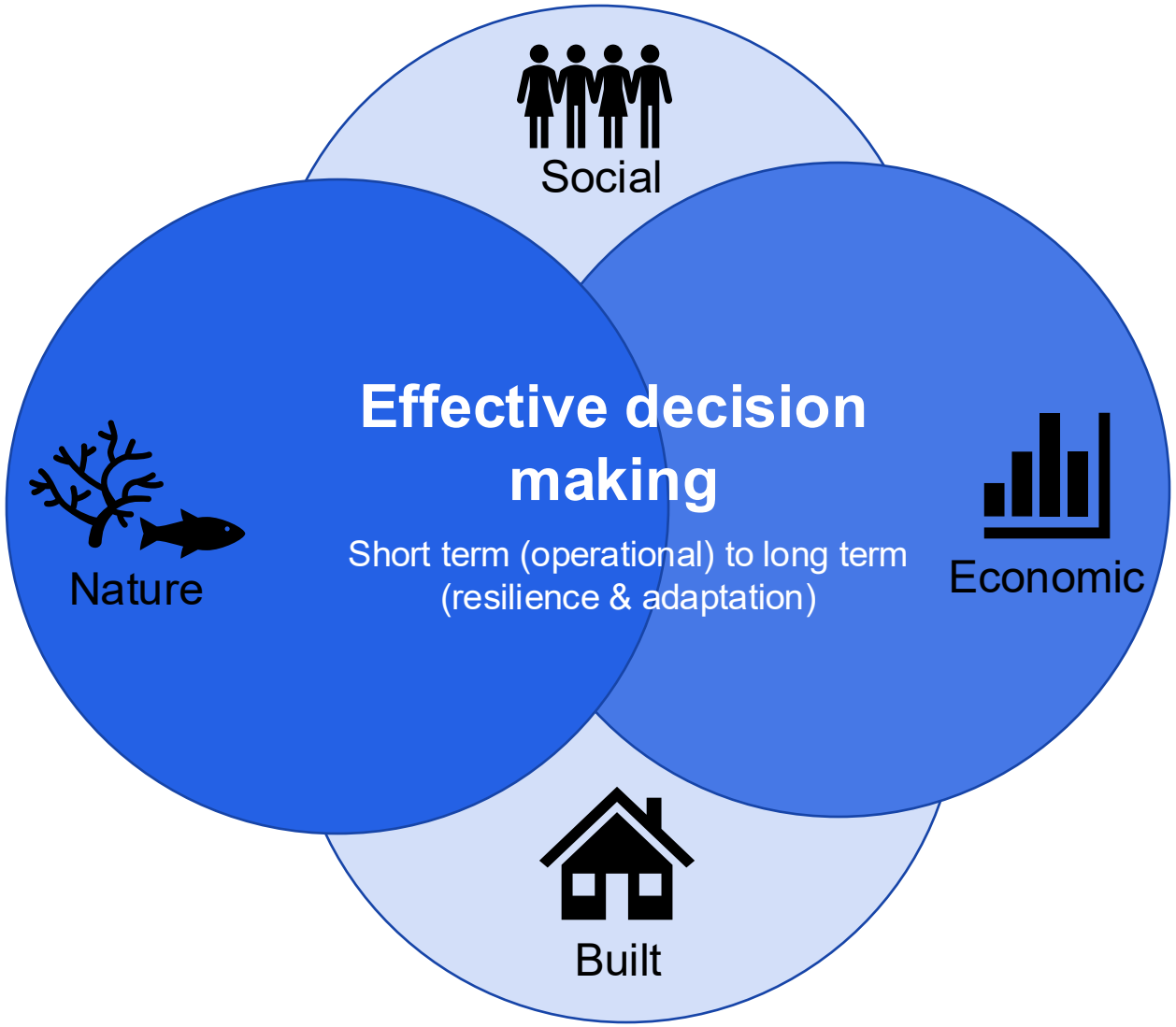
Australian Climate Service

Delivering coastal and ocean hazard information for the Australian Climate Service

Claire Spillman, Ron Hoeke, Claire Trenham, Grant Smith, Vanessa Hernaman, Ryan Holmes, Oceane Richet, Isabela de Souza Cabral, Bryan Hally, Julian O'Grady, Ben Hague, Paul Bierman, Emilio Echevarria, Xuebin Zhang, Alberto Meucci & others

Forum for Operational Oceanography
20 November 2025

The Australian Climate Service



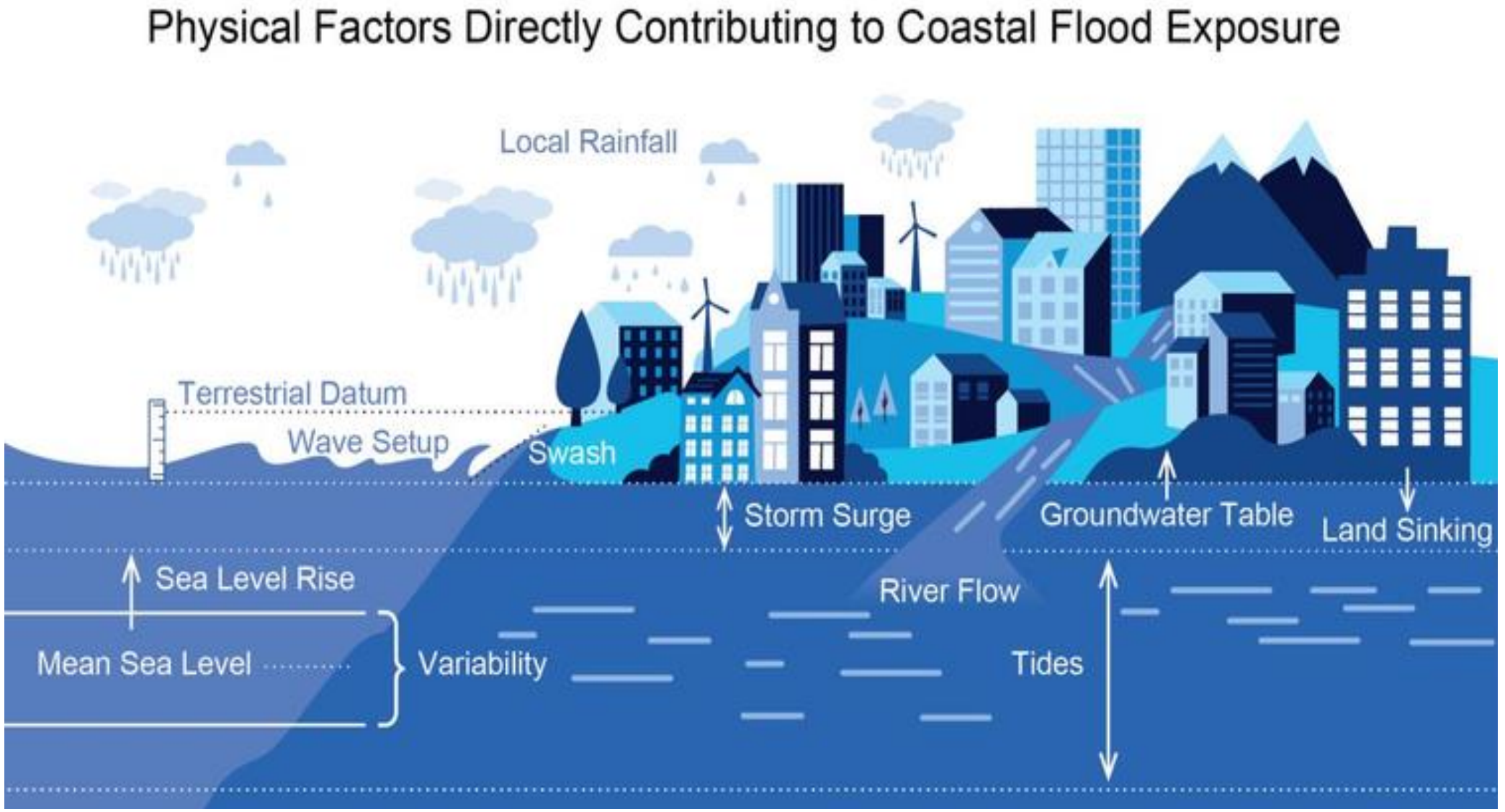
Understand climate risks

- Climate hazards, risks, stressors
- Across time & space scales

Monitor and assess vulnerabilities, risks and potential impacts

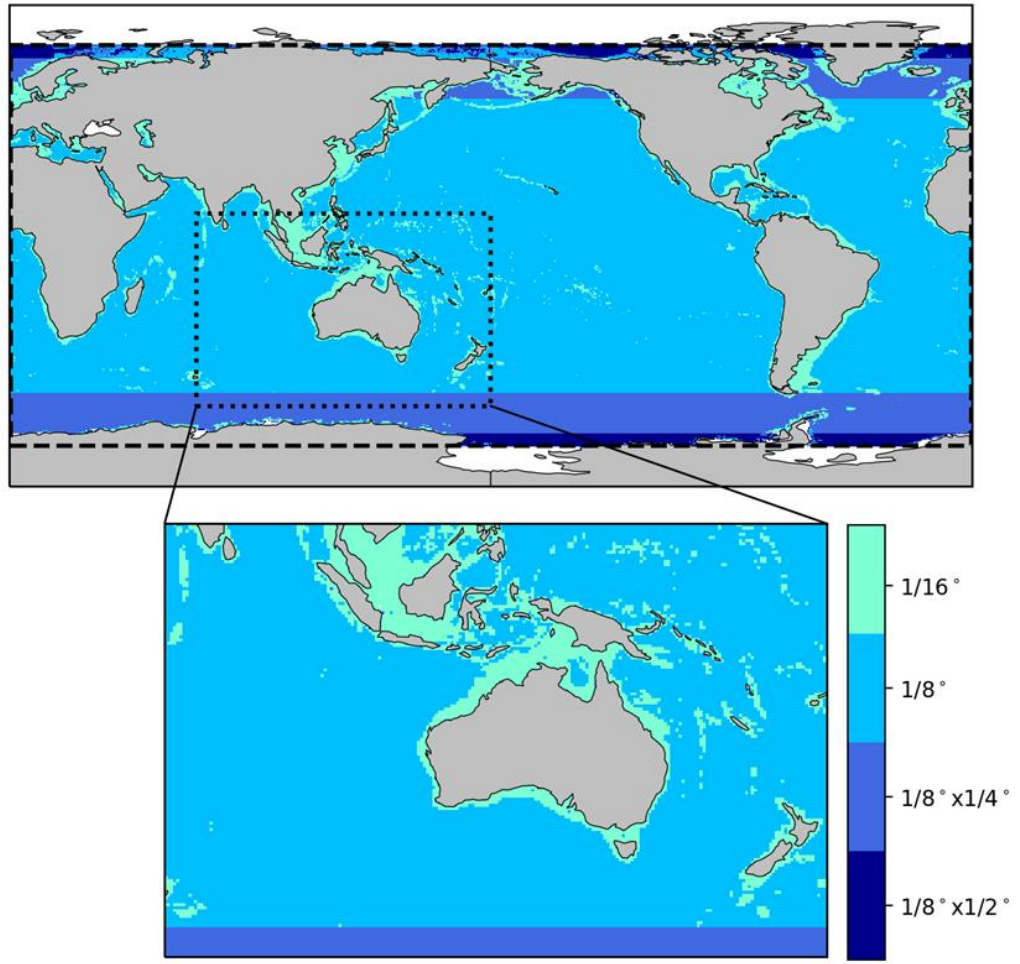
- Monitoring, assessment and advice
- Adaptive capacity & response/mitigation levers
- Across social, economic, natural & built sectors

Coastal hazards.. past, present & future



WHACS: Wave Hindcast for Australian Climate Service

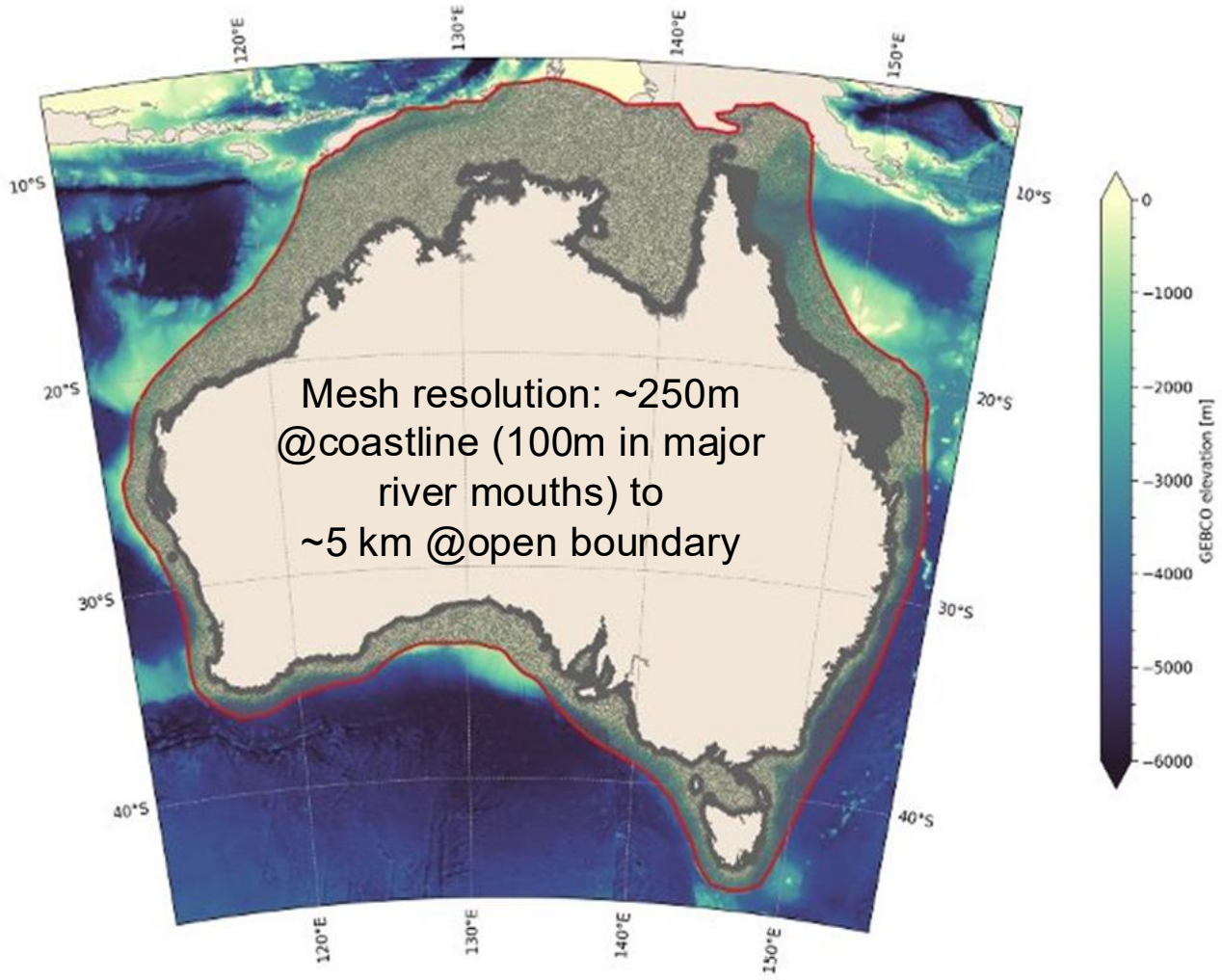
- Next generation global wave hindcast
- Hourly data: 1979-near present
- Latest WaveWatch III version 6.07
- Spherical multi-cell (SMC) grid, aligns with AUSWAVE
- Higher resolution near coasts & on shelf (5 to 7 km)
- Bulk wave parameters available globally & spectral output points across Indo-Pacific country regions
- Driven by ERA-5 winds and ice
- Provides boundary conditions for ACS coastal modelling efforts (CCHaPS)



Data: https://data.csiro.au/collection/csiro:64350
DOI: https://doi.org/10.25919/shdk-7p29

Smith et al in review.

CCHaPS Hindcast



Coupled wave-hydrodynamic Coastal Hazard Prediction System

- SCHISM-WWMIII v5.9
- Water levels, tides, currents and waves
- Unstructured mesh resolution
- BARRA-R2 atmospheric forcing, WHACS waves and TPXO9.2 tides, ORAS5 water levels boundary conditions
- Verified against tide gauges, buoys, profiles, altimetry
- Hourly data; 1981 to near-present

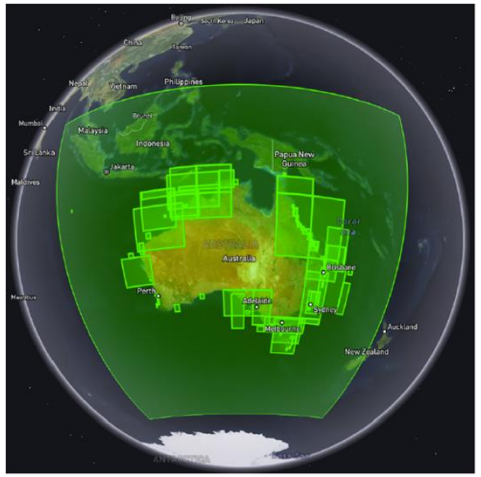
Data: https://data.csiro.au/collection/csiro:65669
DOI: https://doi.org/10.25919/6tbn-px91

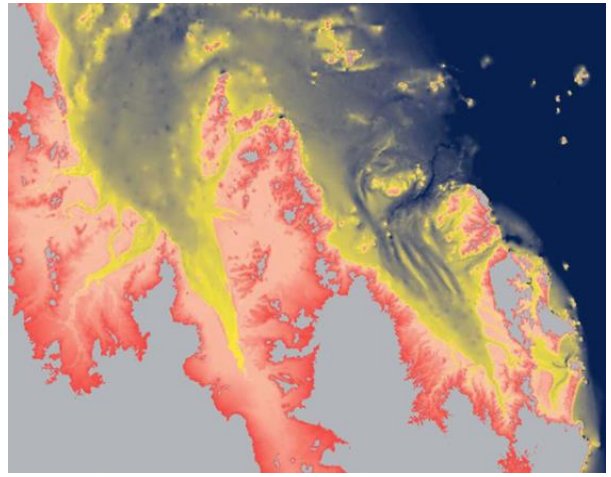
Hernaman et al in review.

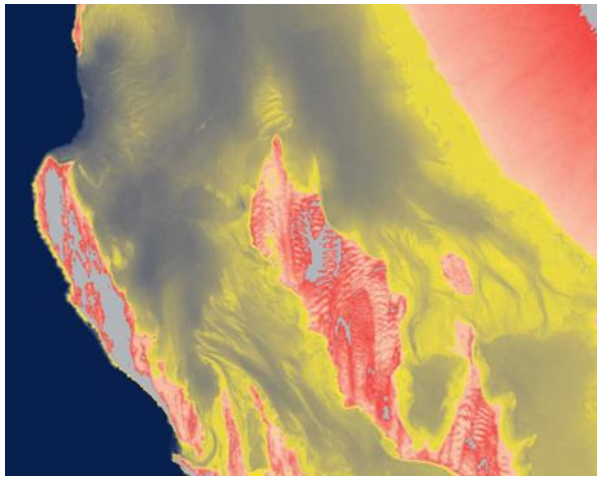
ACS Bathytopography: New DEM for coastal modelling

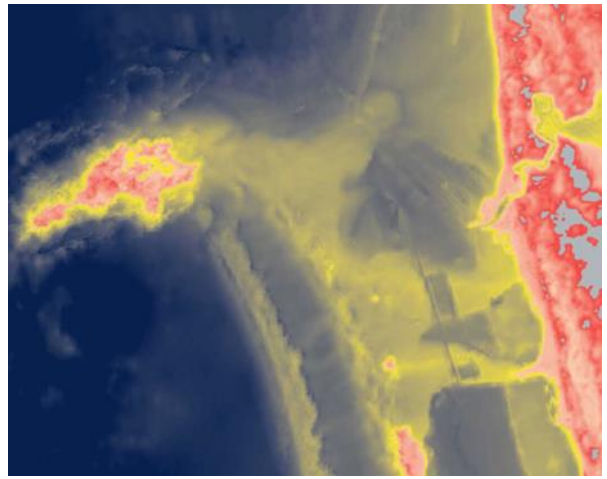
- Updated, authoritative, nationally-consistent topography and bathymetry dataset for Australia
- Up to 30m spatial resolution
- AusBathyTopo/Copernicus GLO-30, with infill bathymetry around the coast where available
- Issued on AVWS vertical datum

Data: https://doi.org/10.25919/y0kc-a922









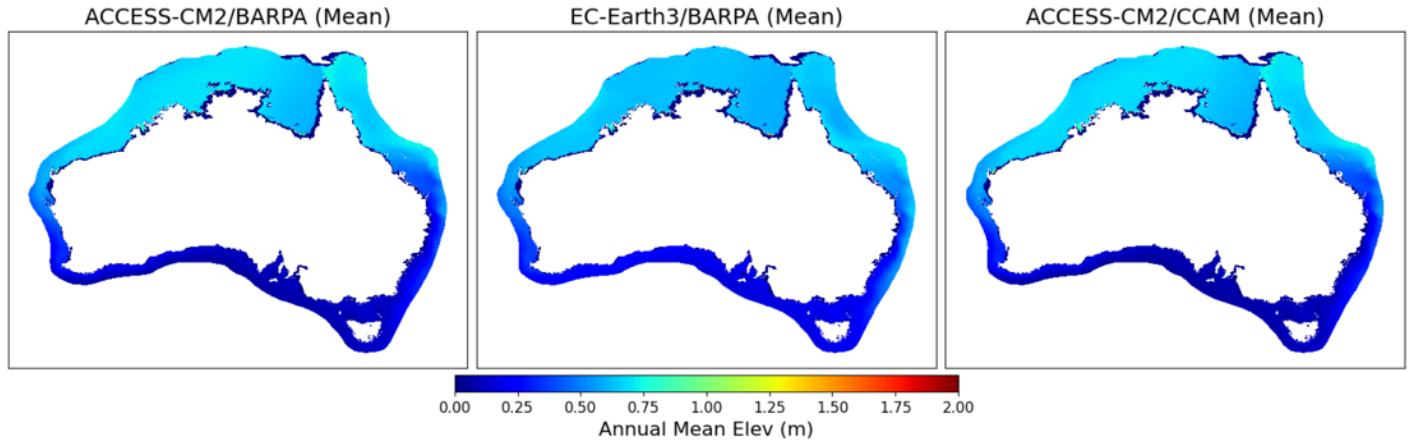
Contact: Bryan Hally (CSIRO)

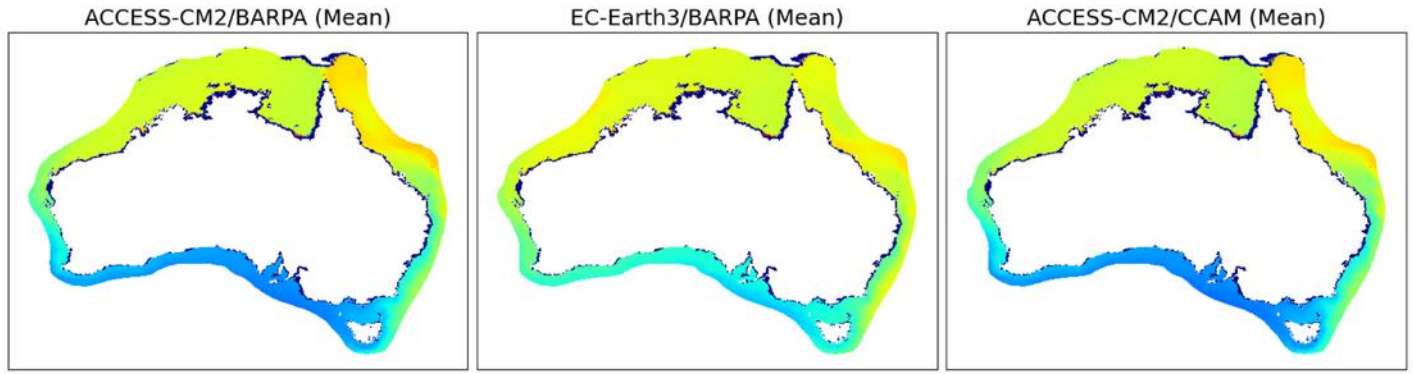
CCHaPS Climate projections

GCM:	ACCESS-CM2; EC-EARTH3
RCM:	BARPA; CCAM
Scenario:	SSP370
Periods:	1995-2014; 2081-2100
SLR:	Regionalised SLR projections (Xuebin Zhang)
Waves:	BARPA-/CCAM-derived wave projections (Alberto Meucci)

Output to be published soon on CSIRO OpenDAP

20-year annual mean 1995-2014





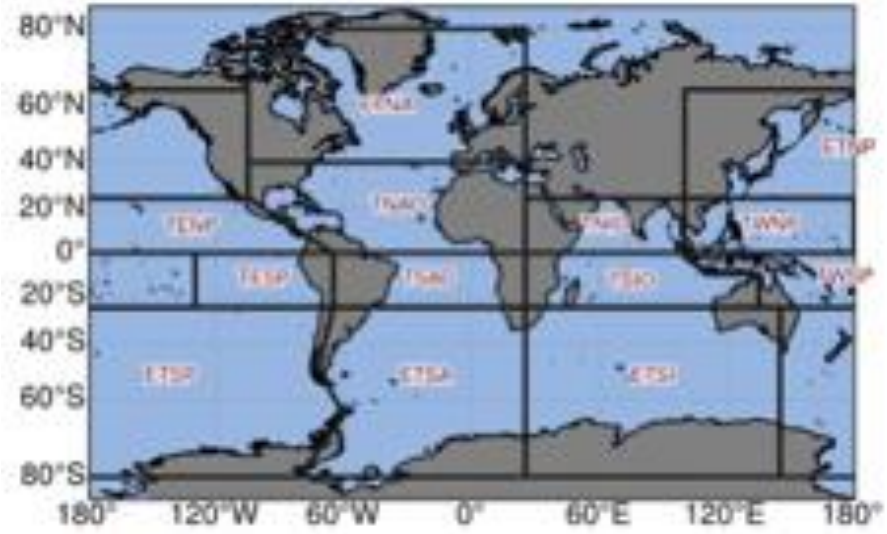
20-year annual mean 2081-2100

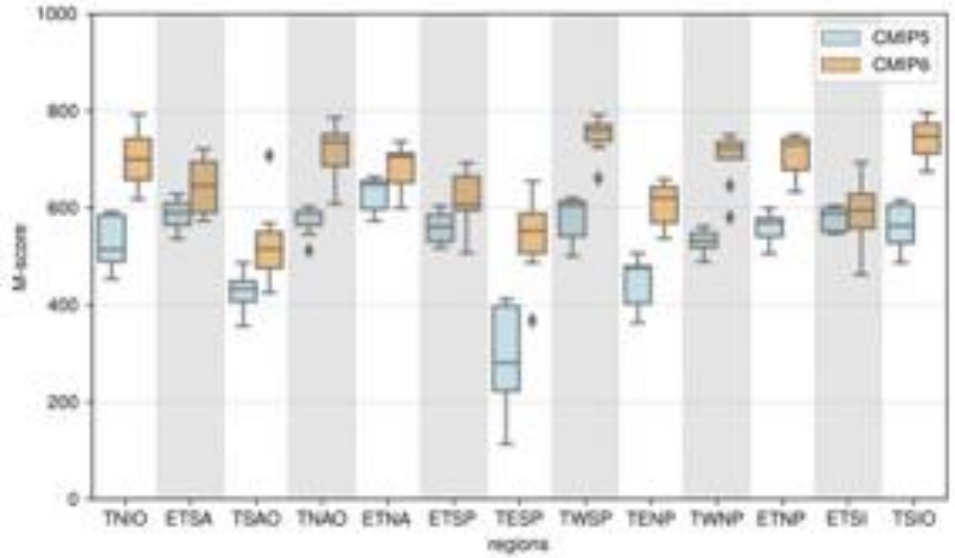
Hernaman et al in review.

Global and regional wave climate projections

- COWCliP CMIP6-derived 8-model ensemble
- Global wind-wave 21st century projections
- BARPA and CCAM-derived regional wave climate projections
  - CCHaPS boundary conditions
  - Study of regional extreme wind wave climate

Data: http://hdl.handle.net/102.100.100/601698

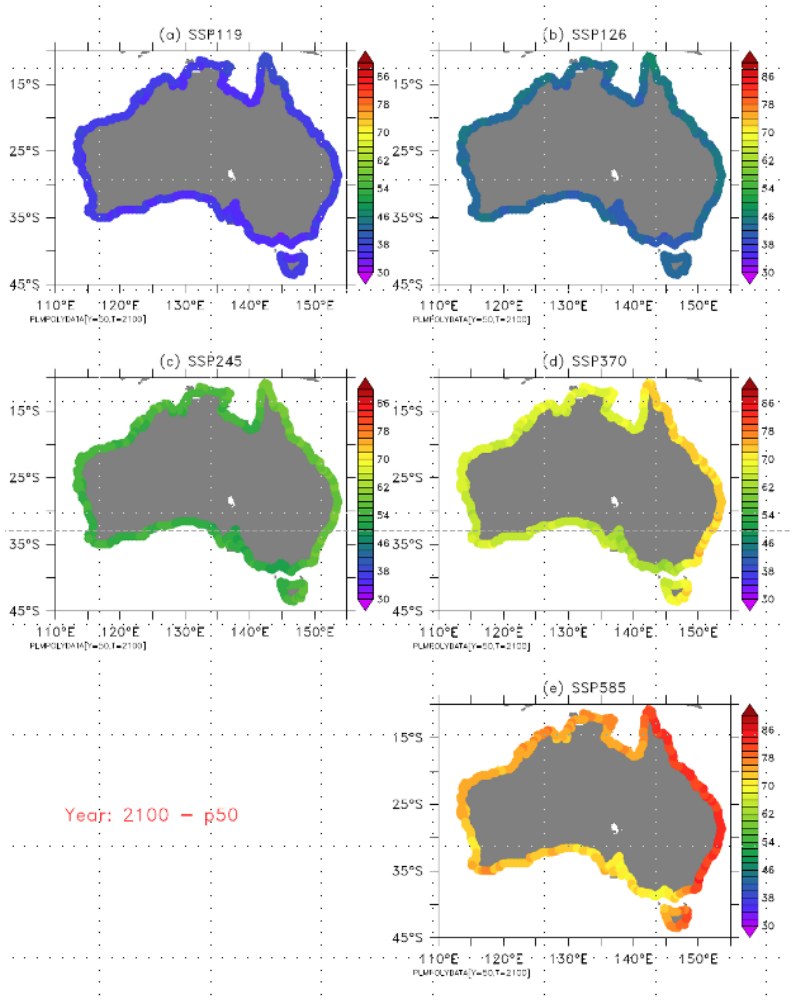




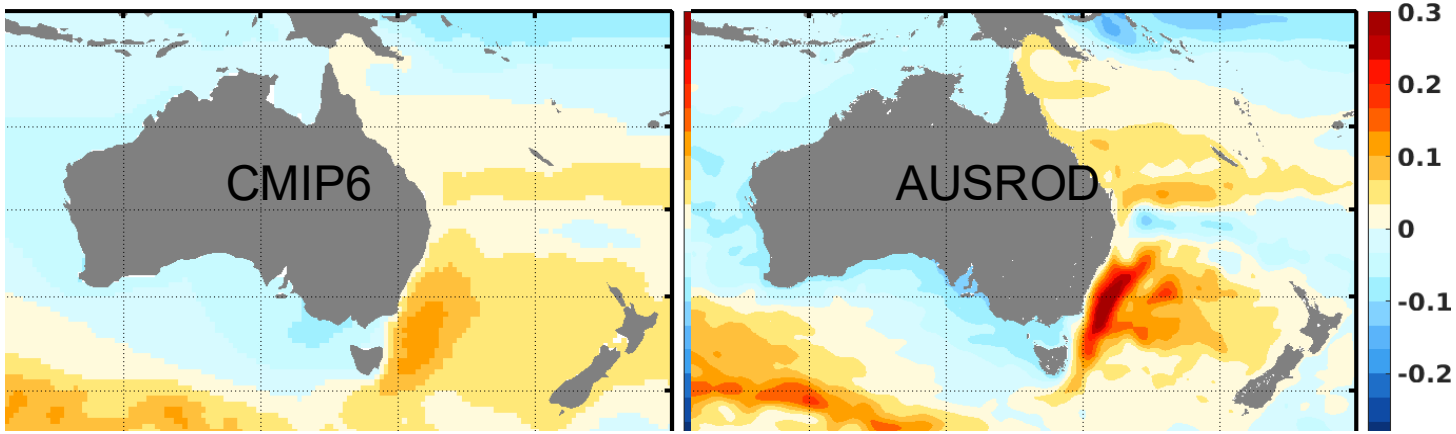
Meucci et al 2024, Meucci et al 2024, Lorenzo & Meucci 2025

Sea level projections and regional ocean downscaling

AR6-based coarse-resolution sea level projections



Australian Regional Ocean Downscaling (AUSROD)

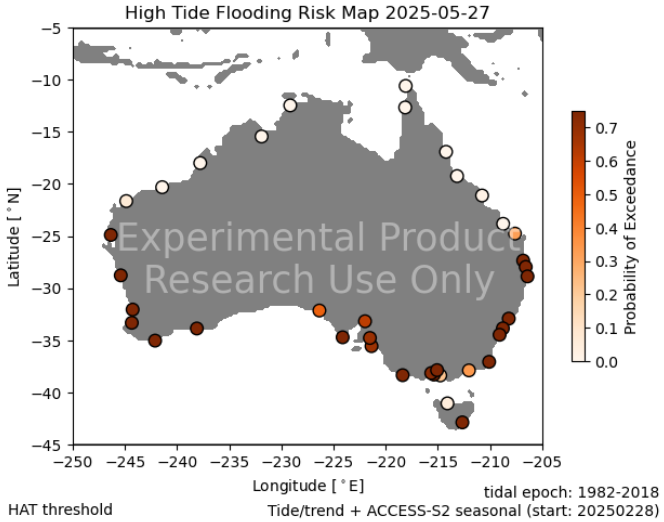


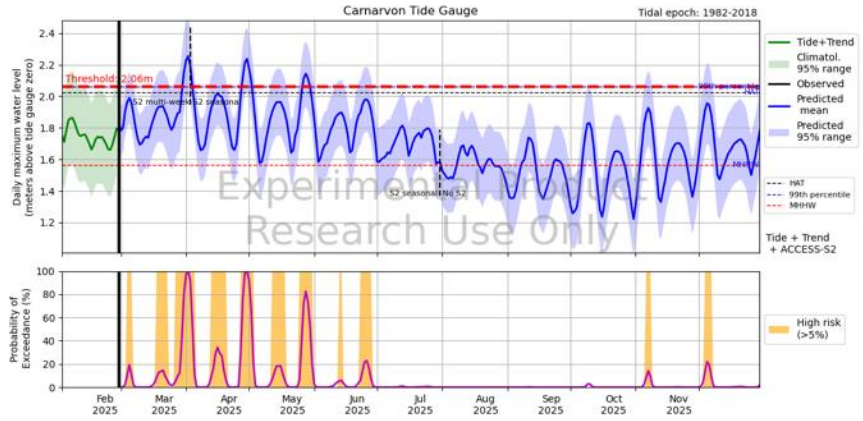
- Optimal regional ocean downscaling set up and configuration for Australia.
- Time-slice and transient downscaling experiments
- International Ocean-CORDEX Taskforce

Zhang and McInnes (2024); Wang, Zhang, Church et al (2025).

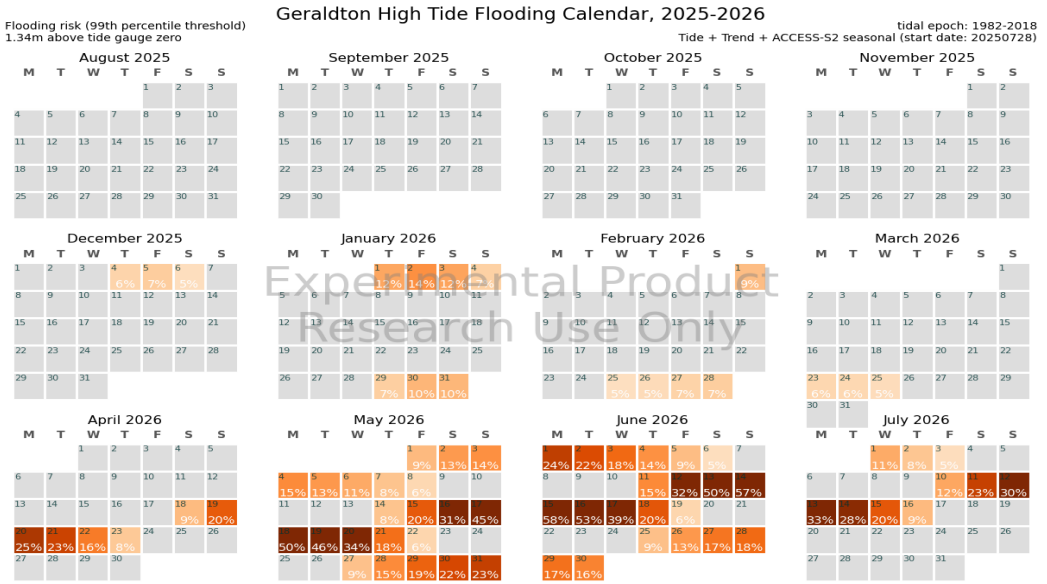
Seasonal Outlooks for Coastal Sea Level & High Tide Flooding

Probabilistic forecasts for daily max sea level and flooding risk from 2 weeks to 12 months ahead





Tides + SLR + storm surge stats + ACCESS-S2 = Daily probability of high tide flooding



- Point-based, option for gridded in future
- Planning operational pathway

Holmes et al 2024; Holmes et al 2025.

Coastal virtual tide gauge network

How can we fill the gaps between coastal tide gauges?

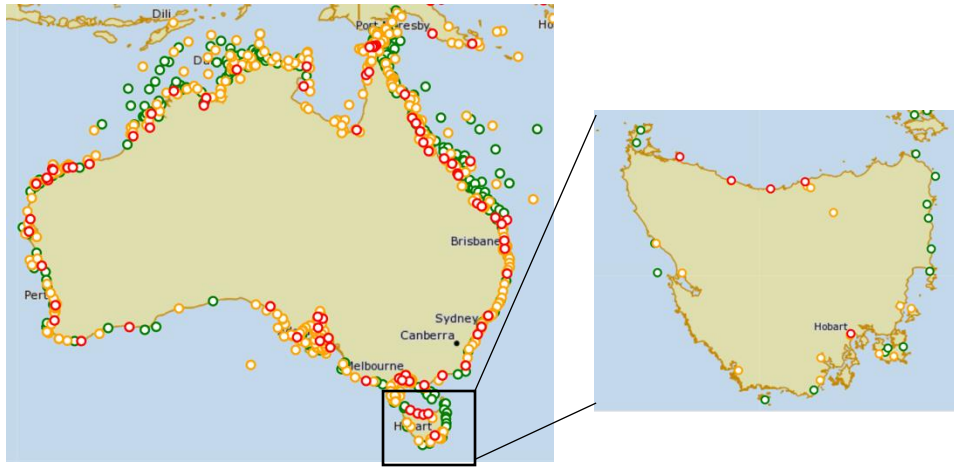
… by creating virtual tide gauges using CCHaPS

Advantages

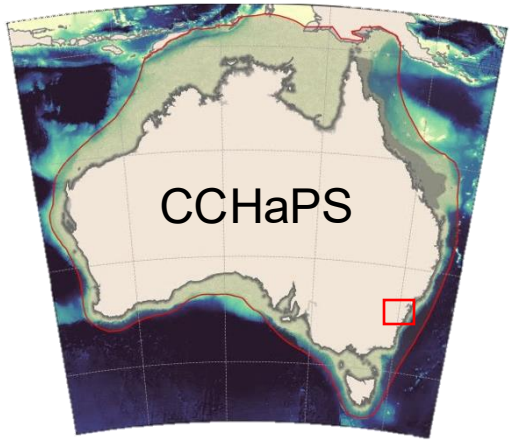
- Regional improvements over global tidal models
- Sea level and non-tidal information alongside tide reconstruction

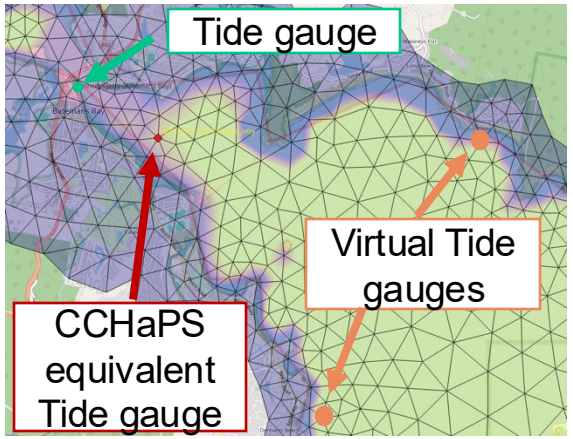
Applications

- Coastal hazards information along whole coast, including high tide flooding
- Improvement of poor observation records
- Improvement of tide prediction location based



Tide gauges used by the Bureau of Meteorology to issue tide prediction and sea level warnings.





Richet et al 2025; Richet et al (in prep).

Coastal Hazard Index (CHI)

Coastal hazard warnings issued by the Bureau:

- **Abnormally High Tide** (AHT) warnings
- **Damaging Surf** (DS) warnings

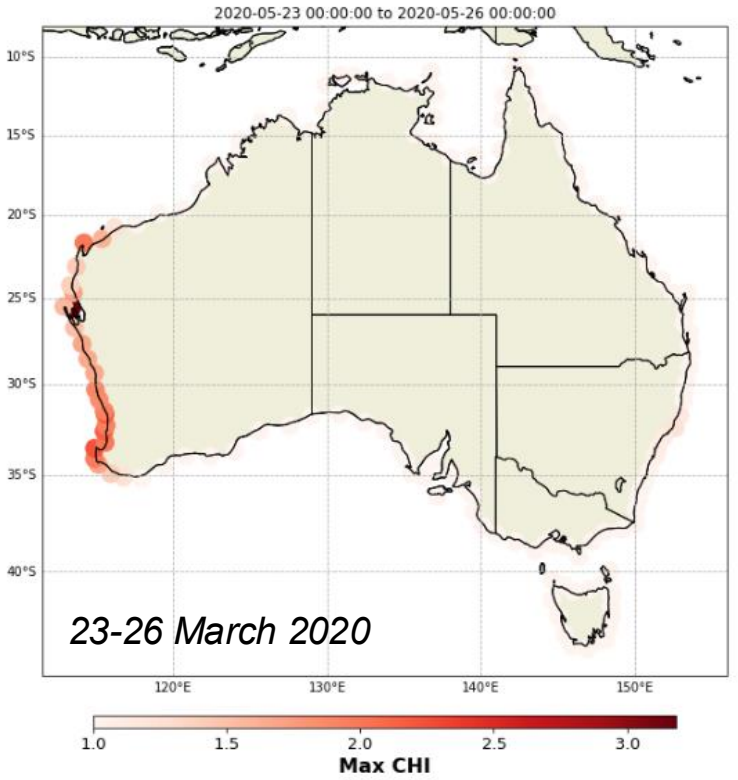
Separate AHT and DS thresholds can lead to sea level and wave guidance being viewed in isolation

CHI = (Relative wave energy flux) x (Relative wave direction index) x (Relative water level)

- **CHI < 1** Minimal to no impacts expected
- **CHI > 1** Impacts possible
- **CHI >> 1** Impacts likely

Thresholds TBC based on past event analysis


ABC News: Nicolas Perpitch



de Souza Cabral, Bierman et al (in prep).

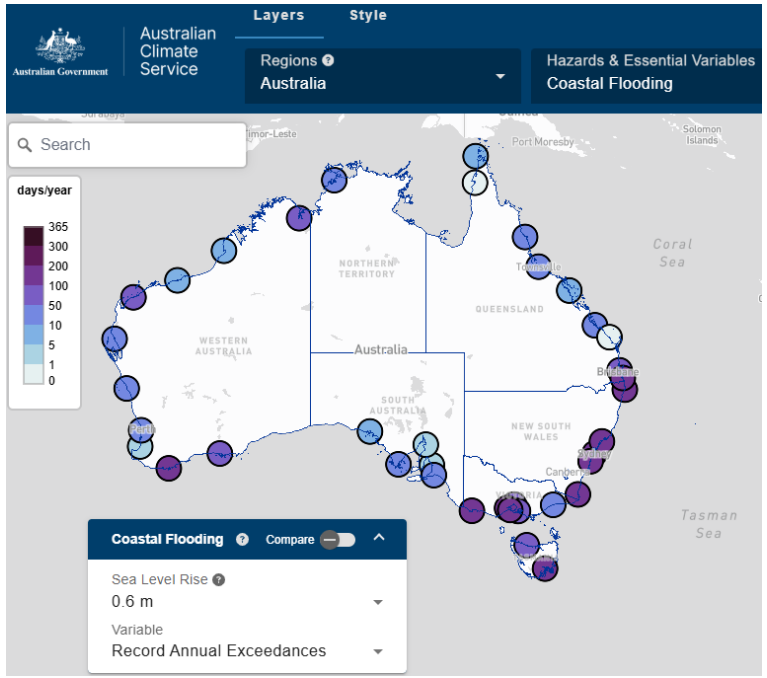
Coastal flooding

- Projections of chronic flooding of different severities and present-day frequencies from ANCHORS under IPCC AR6
- Projections of flood days under SLR increments for GESLA gauges
- Projections of future flood probabilities record flood levels for ANCHORS
- Projected changes in national gridded AEPs for extreme sea level and wind-waves, using EVA analyses of CCHaPS p

Compound flooding?

Hague & Halke (2024); O'Grady et al (2024); Hague et al (in review)

National Climate Risk Assessment



- Comprehensive report + executive summary
- Future Climate & Hazards Report
- Data explorer www.acs.gov.au
- Coincided with release of National Adaptation Plan

	Current rise since 1880	Future change relative to current sea level			
		GWL +1.5/ +2.0°C at 2050	GWL +2.0°C at 2090	GWL +3.0°C at 2090	Planning benchmark
Sea level rise	0.2m	+0.14m	+0.32m	+0.54m	+0.94m
Frequency of coastal flooding	15 days	+24 days	+87 days	+193 days	+257 days
Extreme water level frequency	x 1.0	x 2.0	x 5	x 14	x 101

Future work

- **WHACS-2** with ERA6
- **CCHaPS-2 hindcast** with BARRA-3 & WHACS-2

- Probabilistic TC storm tide & wind wave emulator
- Influence of MSL on tides (past, future)
- Storm surge projections

- Climate drivers of coastal flooding/non-stationary EVA
- Estuary Water Elevation Research (EWER) dataset
- **Compound flooding**, CAMA-FLOOD & CCHaPS
- Develop Coastal Hazard Index (CHI)

And more..!

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Thank you!

claire.spillman@bom.gov.au

www.acs.gov.au

ACS Coastal and Ocean Hazards team:
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