4th International Workshop on Waves, Storm Surges, and Coastal Hazards

25th September 2025

Optimising Storm Surge Response Through an innovative Tropical Cyclone Decision Support Tool: Qsurge Flood

Gaëlle Faivre, **Darrell Strauss**, Ali Golshani, Jan Hattenhausen, Brett Parker, Andrew Bowness, and Joanna Aldridge

g.faivre@griffith.edu.au

d.strauss@griffith.edu.au

Project Structure

Funded by:

Australian and Queensland Government under the Queensland Resilience and Risk Reduction Fund (QRRRF)
Queensland Fire and Emergency Services (QFES)
Griffith University – Cities Research Institute (GU/CRI)

Partners:

Queensland Police Service (QPS)
Queensland Government Department of Environment, Tourism, Science and Innovation (DETSI)
Bureau of Meteorology, Australian Government (GA)
Geoscience Australia, Australian Government (GA)

Timeline: July 2023 - December 2025

QRA Queensland Reconstruction Authority

Queensland Government
Department of Environment and Science

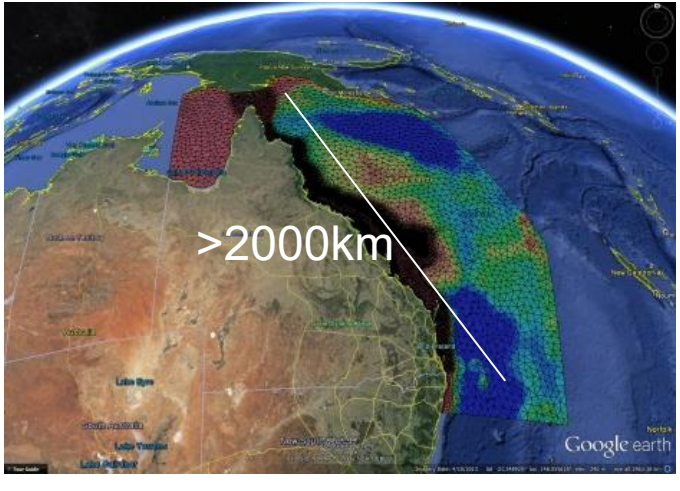
Queensland Police

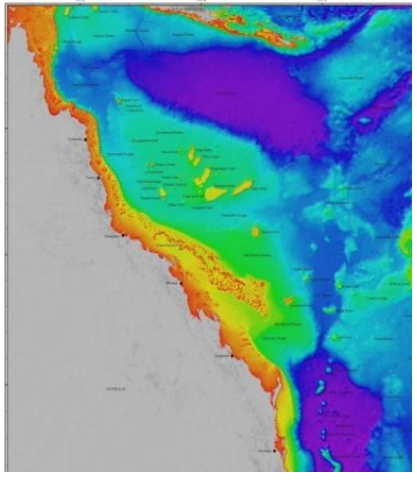
Australian Government
Bureau of Meteorology

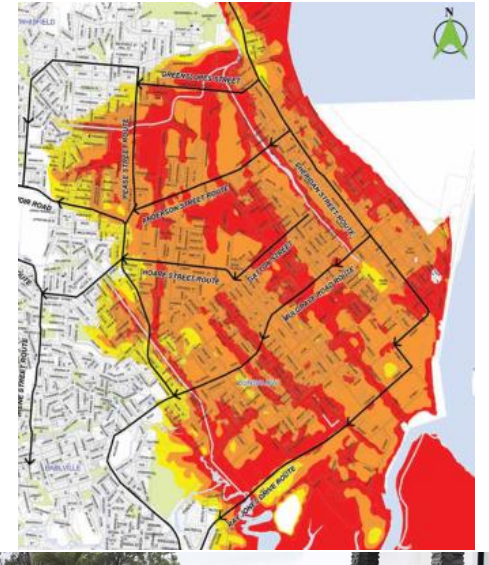
Australian Government
Geoscience Australia

Tropical Cyclone related Storm Surge poses an extreme risk to life in Qld:

- Shallow GBR lagoon and Gulf of Carpentaria
- Funnel shape of Hervey Bay and Moreton Bay
- Low-lying population areas: Townsville, Cairns, Mackay
- Island and isolated communities
- Canal estates of Sunshine Coast and Gold Coast





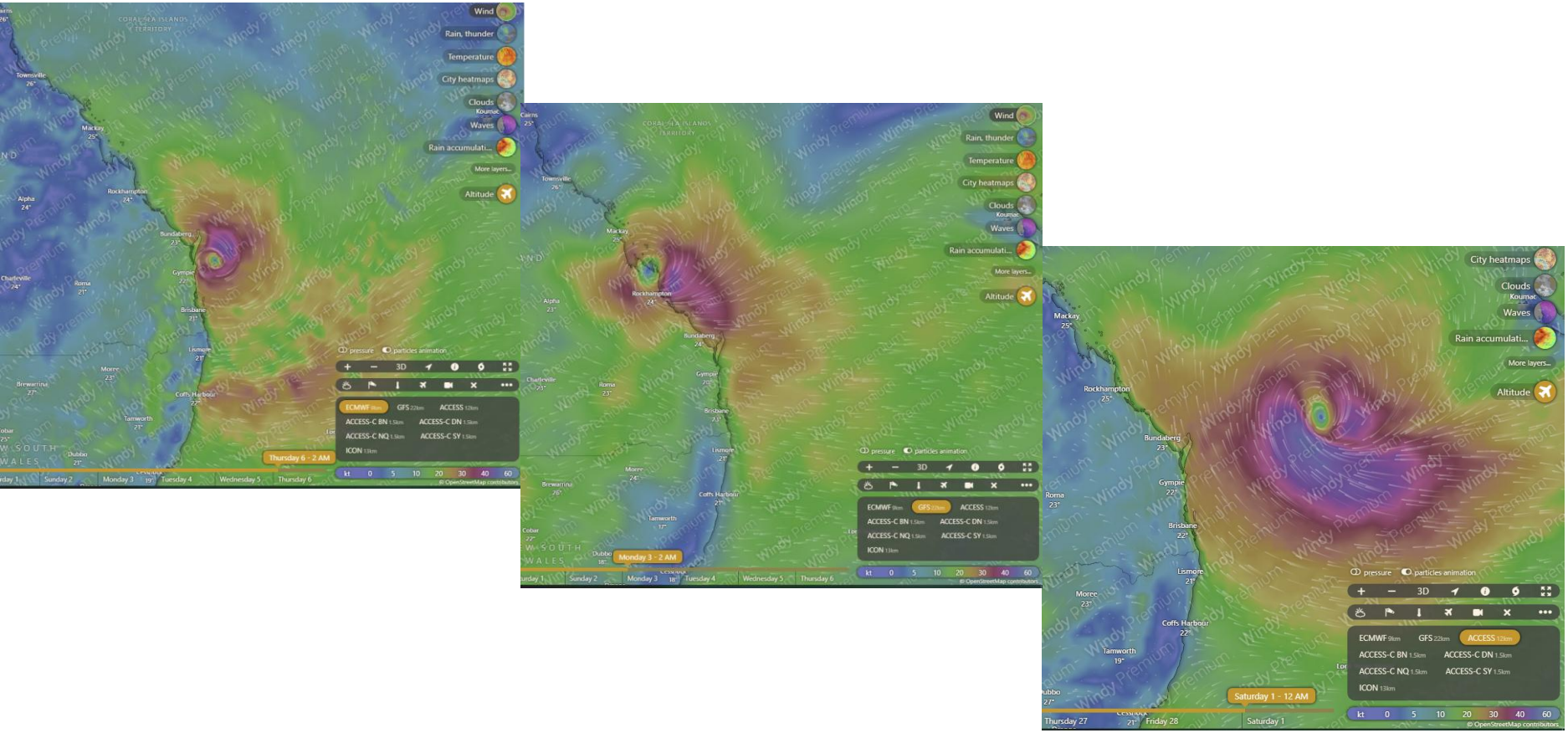


TC Oswald 2013

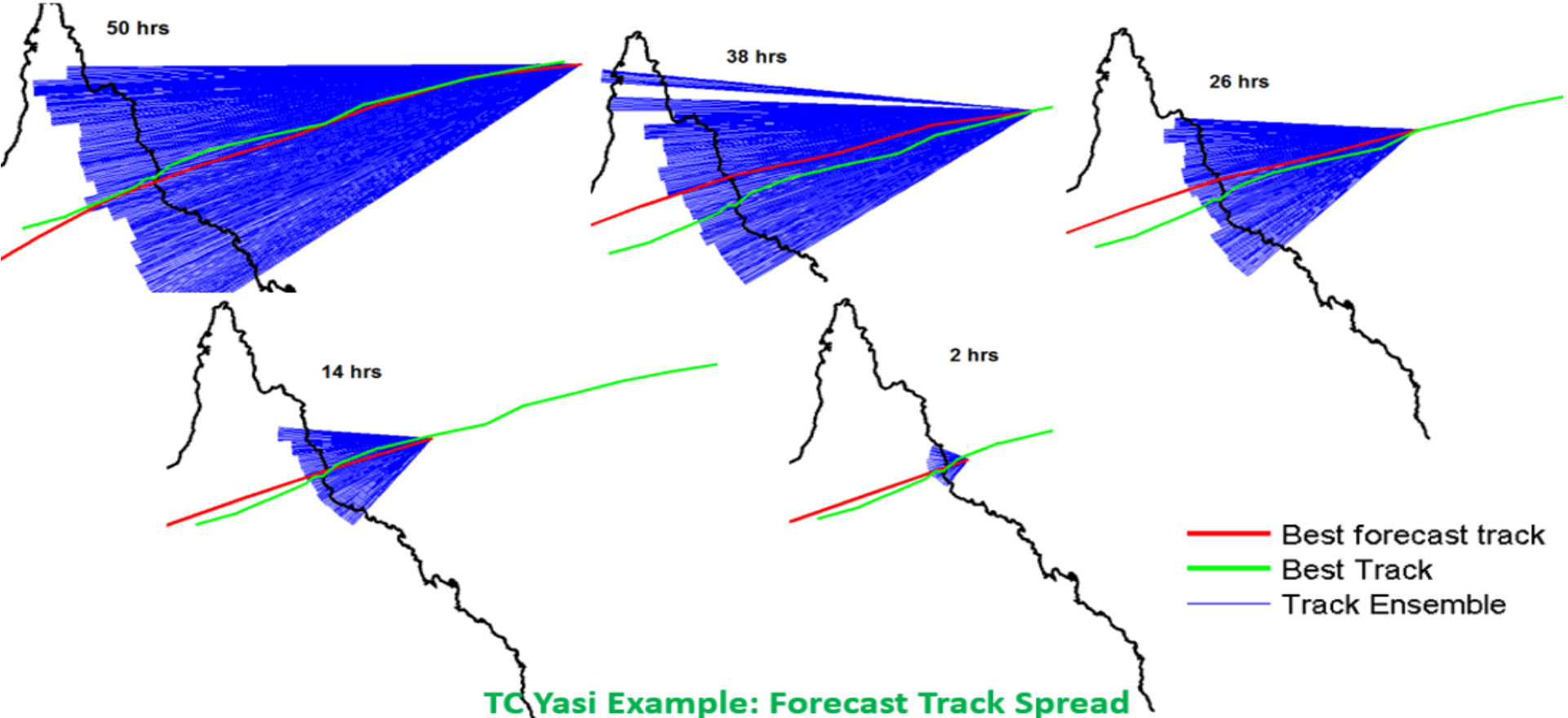
Ex Tropical Cyclone Oswald has whipped up huge and dangerous seas across the Gold Coast. Currumbin Surf Lifesaving Club car park is awash. Pics Adam Head

Ex Tropical Cyclone Oswald has whipped up huge and dangerous seas across the Gold Coast. Pics Adam Head

TC Alfred: February 20, 2025 Forecast -> uncertainties



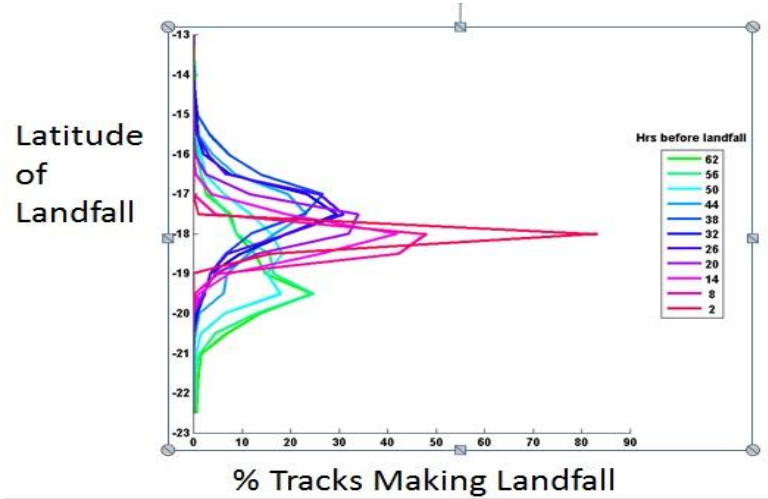
- Forecast cyclone tracks are highly uncertain

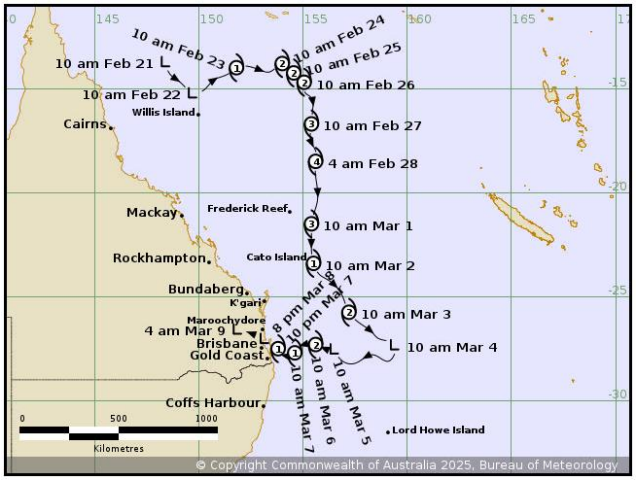


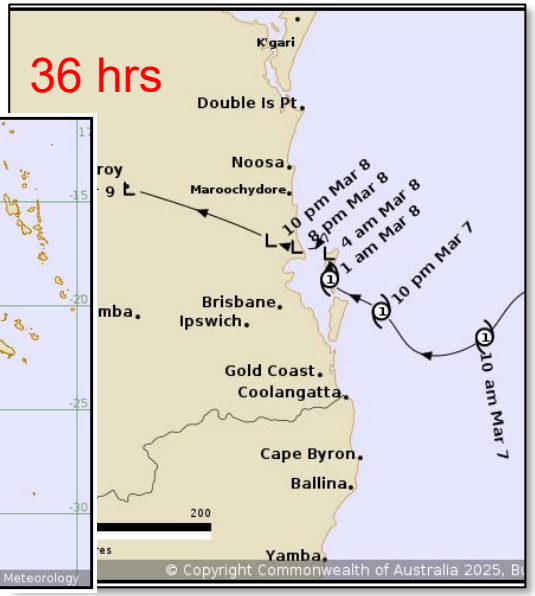
TC Yasi Example: Forecast Track Spread

Key Issues facing Emergency Managers: ***Where, When and How High?***

- **Situational awareness** within a tropical cyclone event of high winds and rainfall
- **High degree of uncertainty** in forecast of cyclone track and intensity
- **Magnitude** of surge highly sensitivity to local bathymetry, track orientation etc
- **Timing** of peak surge with phase of tide
- Understanding **extent** and **impacts** of inundation







AIM

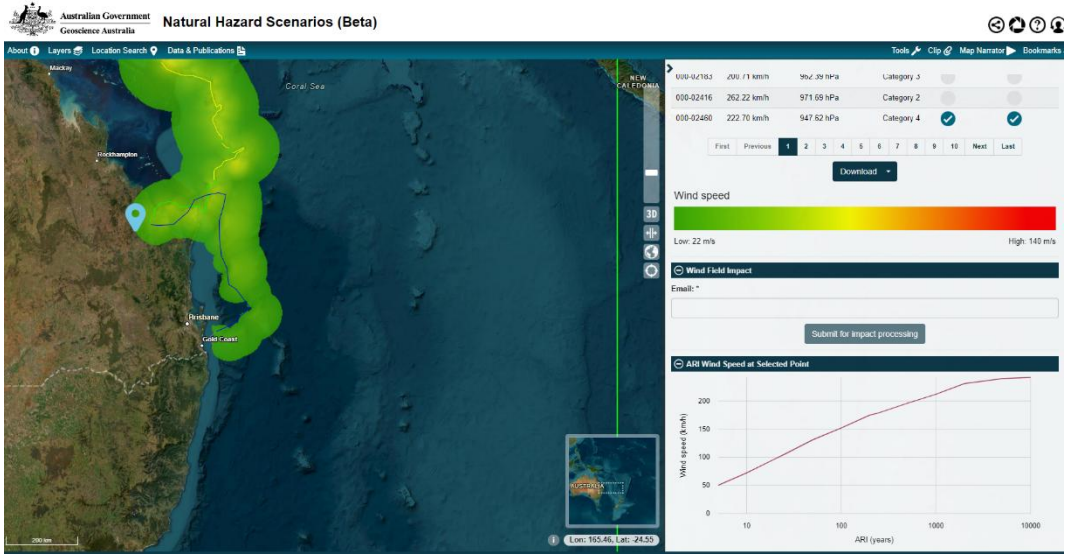
Support disaster management authorities with timely and accurate information through a pilot decision support system for predicting storm surge inundation associated with tropical cyclones in coastal Queensland, and in the Gulf of Carpentaria

- Improve planning → Disaster managers could use SurgeImpact to run “what if” scenarios so you could plan for varying options
- Capacity to optimise disaster response operations → Ability to visualise the inundation extent and spatial variation
- Impact assessment → Capacity to export the inundation layer to a GIS system, other hazards, flood, wind, evacuation routes
- Improve consistency of communication of hazard information between agencies
- Timeliness of information under real-time pressure

SurgeImpact: Impact Assessment

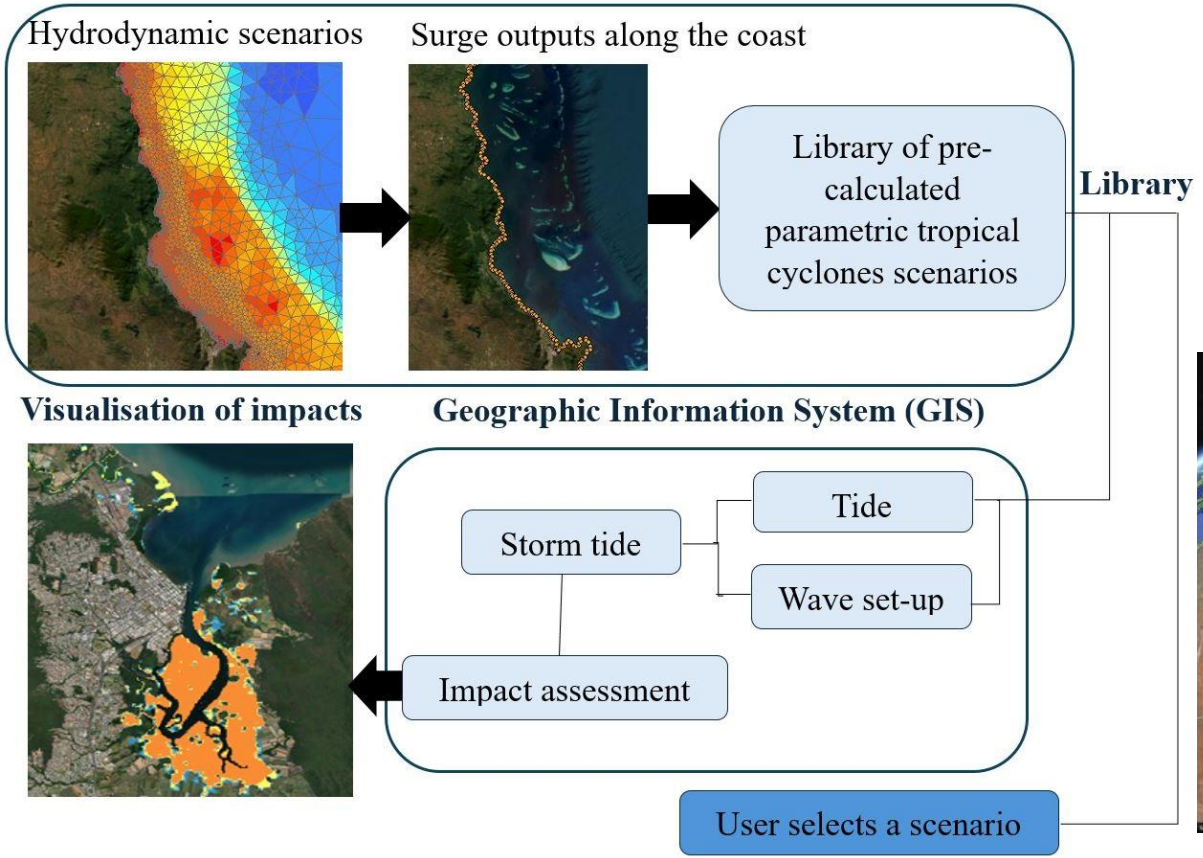
Geoscience Australia

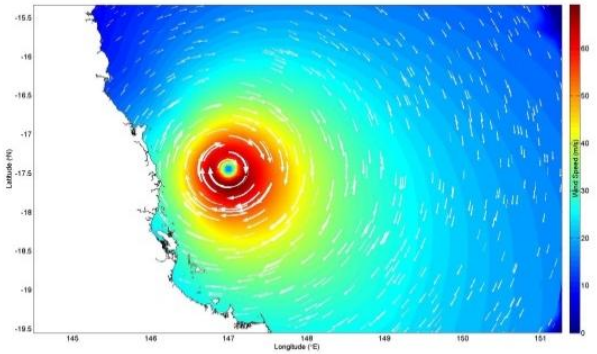
- Extend capabilities of National Hazard Impact and Risk Service (NHIRS) portal for storm surge impacts
- Intersect expected inundation with built environment:
  - Properties affected
  - Degree of damage
  - Roads

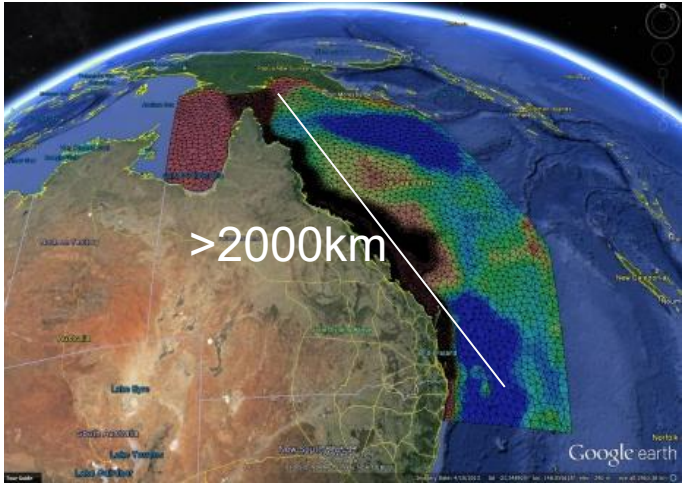


National Hazard Impact and Risk Service (NHIRS) portal: Sample TC Impact

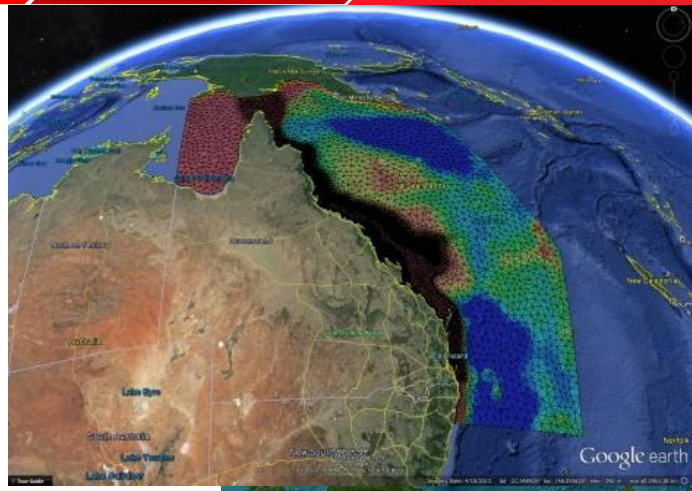
Strategy of stormsurge project







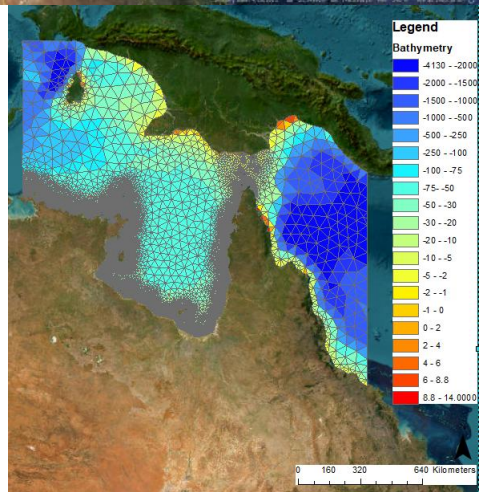
Hydrodynamic model



- Idealised tropical cyclone wind/pressure field model (Holland et al. (2010))
- High resolution hydrodynamic modelling in MIKE21 FM
- Spatial resolution: 1-2 km in nearshore (to 150m for complex bathy)
  ~2 km over GBR
- ~113 899 elements and 59 266 nodes (East Coast)
- 231000 elements and 123500 nodes (Gulf Carpentaria)
- Smallest elements ~150 m
- Best available bathymetry from multiple agencies
- 3 tidal boundaries
- Covers entire Qld coastline
- 20 tidal calibration sites (MSQ and NTC Tidal Data)

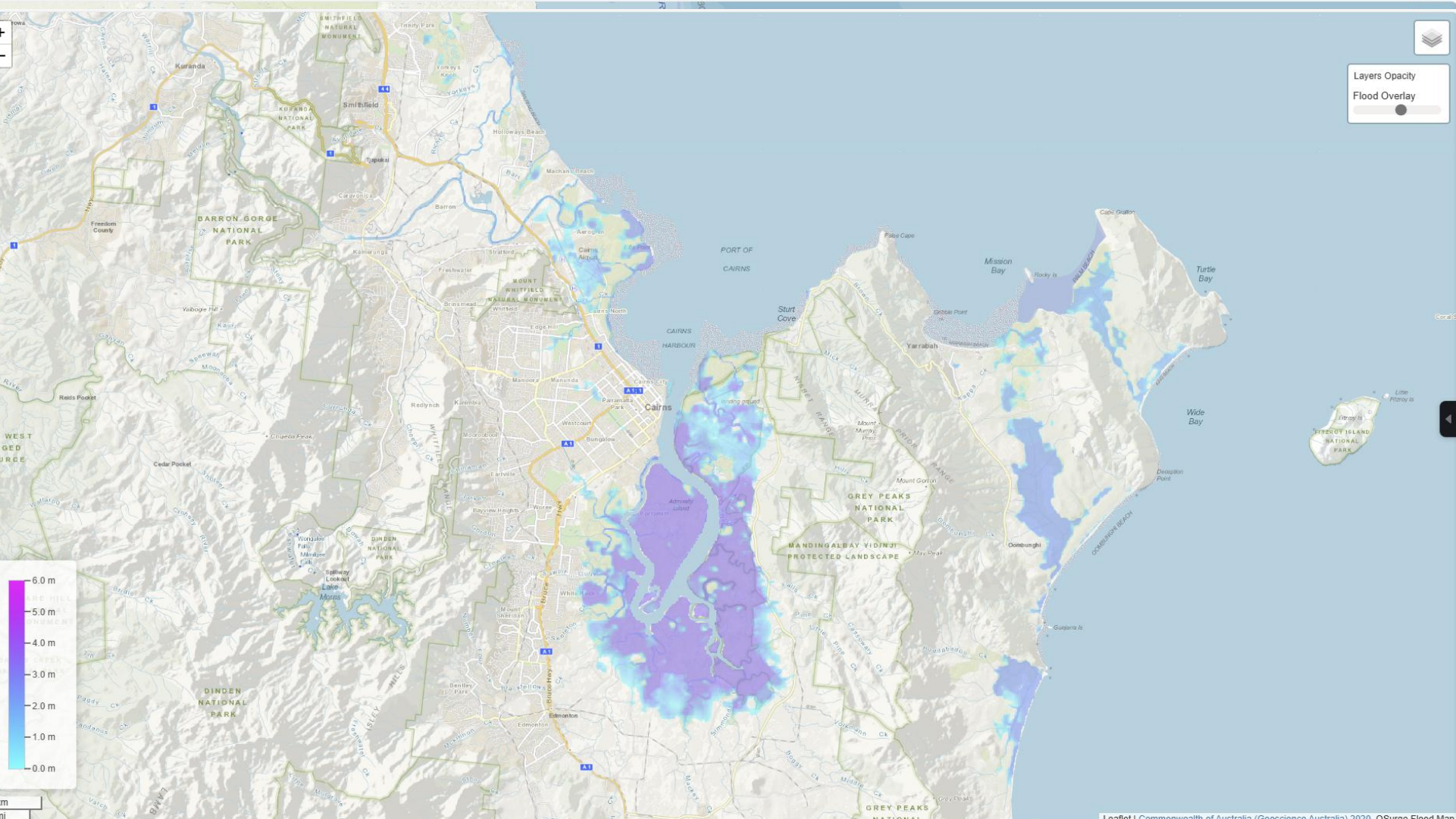
Inundation Model:

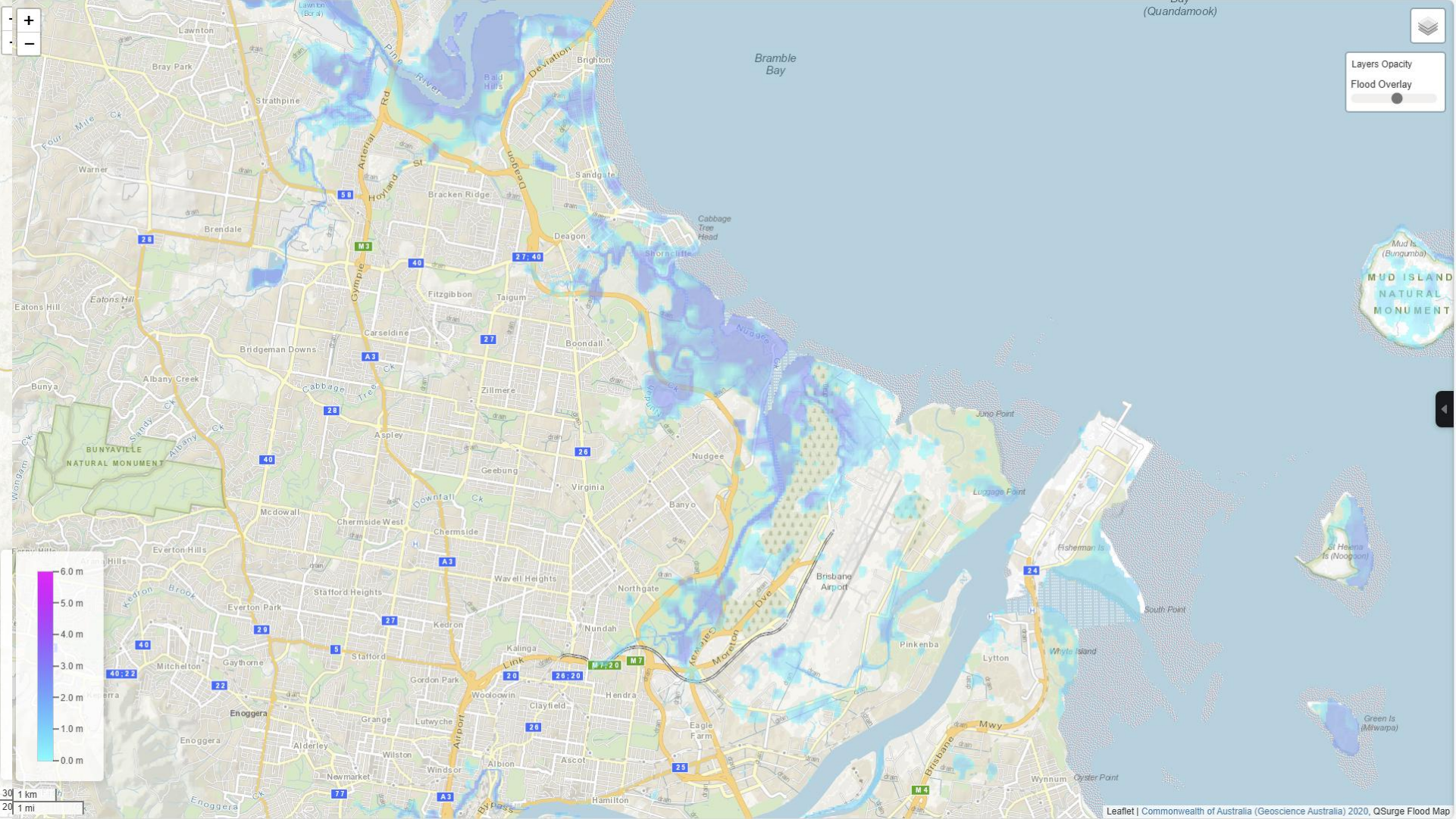
- Provides comprehensive coverage of the entire Australian coastline for resolution of up to 1 m

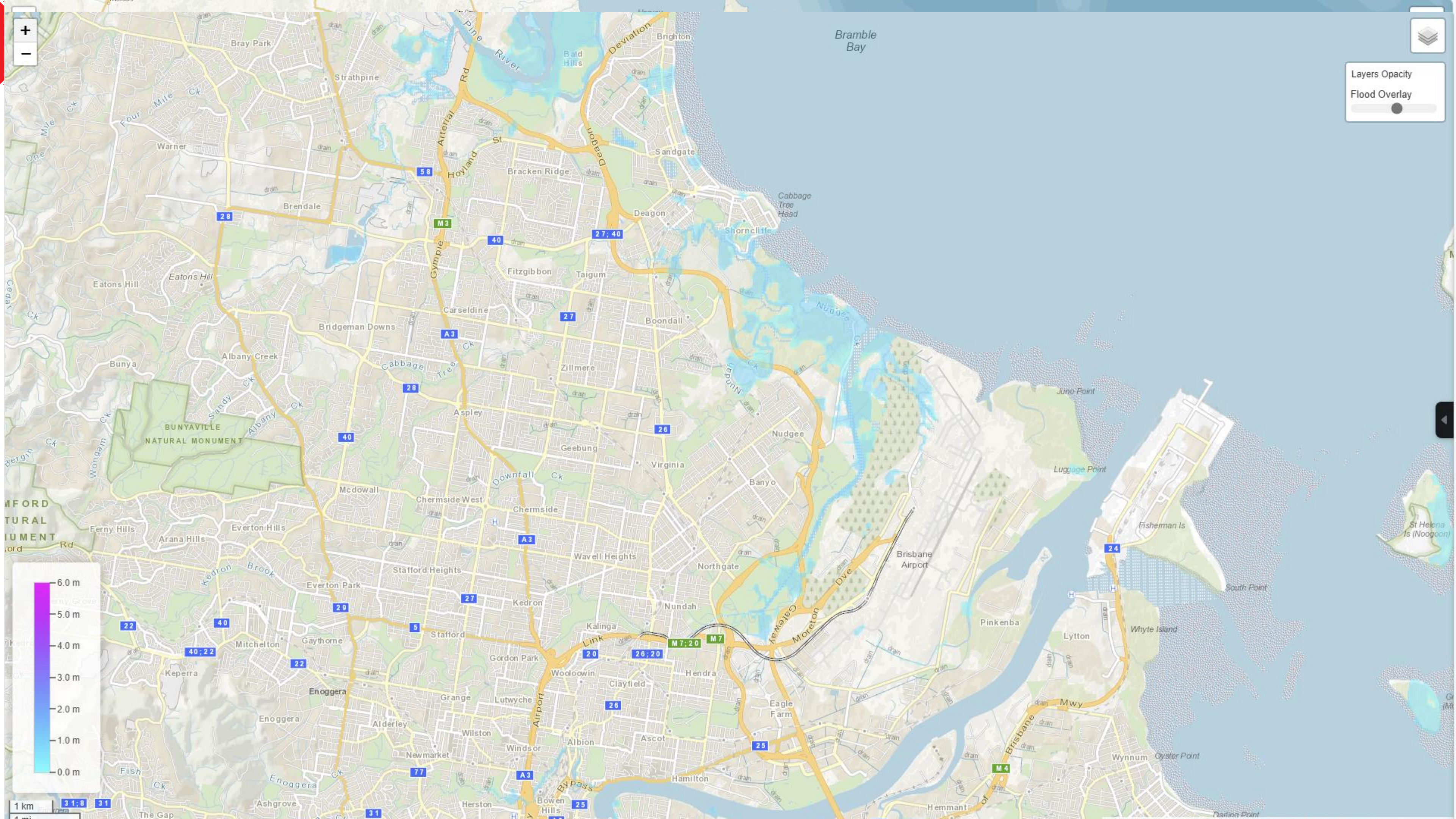


For the east coast

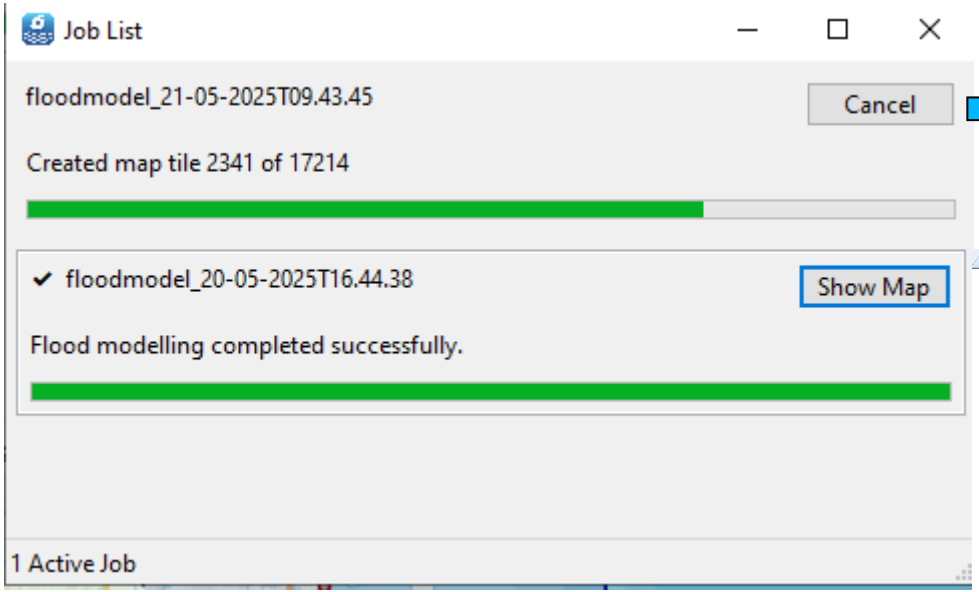
Parameters	Scenarios	Increments	Extend
Landfall Points	729	5 km	Covering 6973 km of coastline
Angle of Approach	28	10°	0 to 270
Central Pressure	21	5 hPa	900 to 1000
Radius of Maximum Wind	6	10 km	10 to 60 km
Forward Speed	7	2 m/s	2 to 14 m/s
Total scenarios	**18,003,384**		

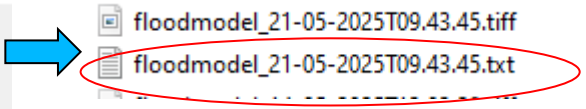

Layers Opacity
Flood Overlay
6.0 m
5.0 m
4.0 m
3.0 m
2.0 m
1.0 m
0.0 m
Kuranda
Smithfield
BARRON GORGE NATIONAL PARK
DINDEN NATIONAL PARK
PORT OF CAIRNS
CAIRNS HARBOUR
Cairns
Sturt Cove
Yarrabah
Mission Bay
Turtle Bay
Wide Bay
GREY PEAKS NATIONAL PARK
MANDINGALBAY YIDINJI PROTECTED LANDSCAPE
Dombunghi
Lake Morris
Edmonton
Leaflet | Commonwealth of Australia (Geoscience Australia) 2020, QSuper Flood Map

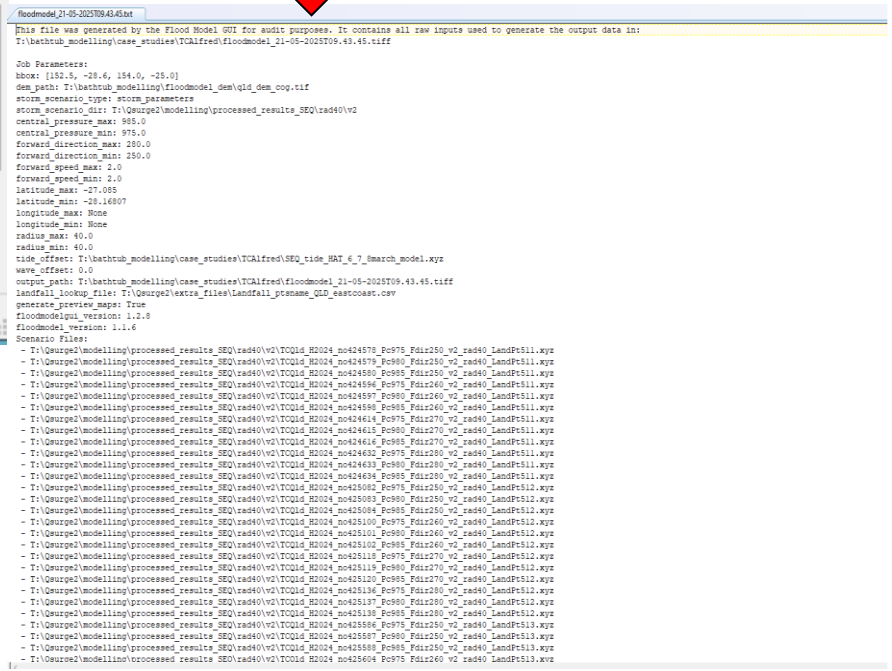

Layers Opacity
Flood Overlay
6.0 m
5.0 m
4.0 m
3.0 m
2.0 m
1.0 m
0.0 m
Bramble Bay
(Quandamook)
MUD ISLAND NATURAL MONUMENT
BUNYAVILLE NATURAL MONUMENT
Brisbane Airport
Leaflet | Commonwealth of Australia (Geoscience Australia) 2020, QSurge Flood Map



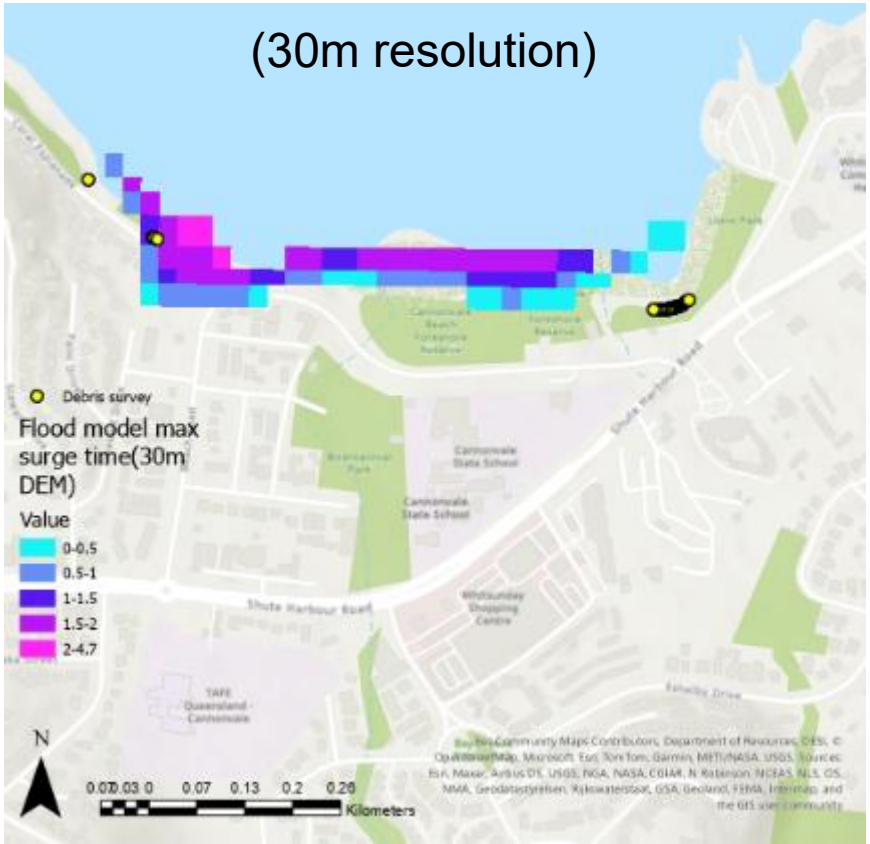
Layers Opacity
Flood Overlay
6.0 m
5.0 m
4.0 m
3.0 m
2.0 m
1.0 m
0.0 m
1 km
Bramble Bay
Bray Park
Strathpine
Brighton
Bald Hills
Pine River
Sandgate
Warner
Bracken Ridge
Brendale
Deagon
Cabbage Tree Head
Shorncliffe
Fitzgibbon
Taigum
Eatons Hill
Carseldine
Boondall
Bridgeman Downs
Zillmere
Albany Creek
Bunya
Aspley
BUNYAVILLE NATURAL MONUMENT
Nudgee
Geebung
Virginia
Banyo
Juno Point
Luggage Point
Mcdowall
Chermside West
Chermside
Fisherman Is
St Helena Is (Noogoon)
Ferny Hills
Arana Hills
Everton Hills
Wavell Heights
Northgate
Brisbane Airport
Stafford Heights
Everton Park
South Point
Kedron
Nundah
Pinkenba
Whyte Island
Lytton
Kalinga
Mitchelton
Gaythorne
Stafford
Gordon Park
Wooloowin
Hendra
Keperra
Clayfield
Enoggera
Grange
Lutwyche
Eagle Farm
Alderley
Wilston
Albion
Ascot
Newmarket
Windsor
Wynnum
Oyster Point
Hamilton
Ashgrove
Herston
Bowen Hills
Hemmant
The Gap

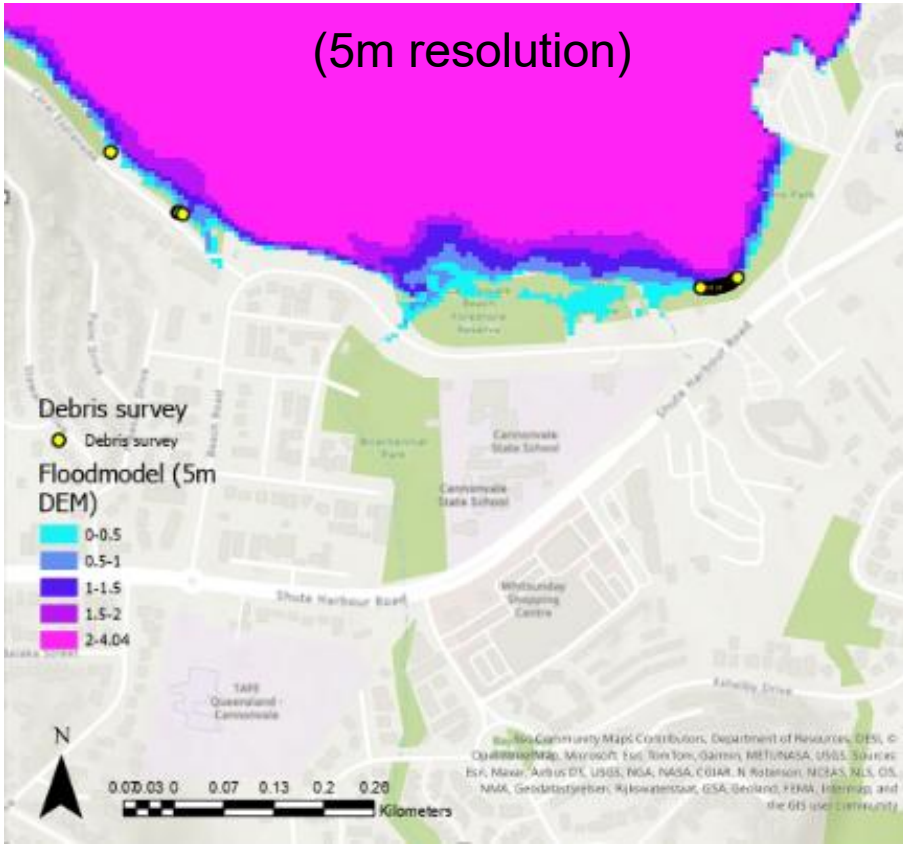

Job List
floodmodel_21-05-2025T09.43.45
Cancel
Created map tile 2341 of 17214
floodmodel_20-05-2025T16.44.38
Show Map
Flood modelling completed successfully.
1 Active Job


floodmodel_21-05-2025T09.43.45.tiff
floodmodel_21-05-2025T09.43.45.txt


floodmodel_21-05-2025T09.43.45.txt
This file was generated by the Flood Model GUI for audit purposes. It contains all raw inputs used to generate the output data in:
T:\bathtub_modelling\case_studies\TCAlfred\floodmodel_21-05-2025T09.43.45.tiff
Job Parameters:
bbox: [152.5, -28.6, 154.0, -25.0]
dem_path: T:\bathtub_modelling\floodmodel_dem\qld_dem_cog.tif
storm_scenario_type: storm_parameters
storm_scenario_dir: T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2
central_pressure_max: 985.0
central_pressure_min: 975.0
forward_direction_max: 280.0
forward_direction_min: 250.0
forward_speed_max: 2.0
forward_speed_min: 2.0
latitude_max: -27.085
latitude_min: -28.16807
longitude_max: None
longitude_min: None
radius_max: 40.0
radius_min: 40.0
tide_offset: T:\bathtub_modelling\case_studies\TCAlfred\SEQ_tide_HAT_6_7_8march_model.xyz
wave_offset: 0.0
output_path: T:\bathtub_modelling\case_studies\TCAlfred\floodmodel_21-05-2025T09.43.45.tiff
landfall_lookup_file: T:\Qsurge2\extra_files\Landfall_ptsname_QLD_eastcoast.csv
generate_preview_maps: True
floodmodelgui_version: 1.2.8
floodmodel_version: 1.1.6
Scenario Files:
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424578_Pc975_Fdir250_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424579_Pc980_Fdir250_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424580_Pc985_Fdir250_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424596_Pc975_Fdir260_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424597_Pc980_Fdir260_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424598_Pc985_Fdir260_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424614_Pc975_Fdir270_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424615_Pc980_Fdir270_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424616_Pc985_Fdir270_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424632_Pc975_Fdir280_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424633_Pc980_Fdir280_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no424634_Pc985_Fdir280_v2_rad40_LandPt511.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425082_Pc975_Fdir250_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425083_Pc980_Fdir250_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425084_Pc985_Fdir250_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425100_Pc975_Fdir260_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425101_Pc980_Fdir260_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425102_Pc985_Fdir260_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425118_Pc975_Fdir270_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425119_Pc980_Fdir270_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425120_Pc985_Fdir270_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425136_Pc975_Fdir280_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425137_Pc980_Fdir280_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425138_Pc985_Fdir280_v2_rad40_LandPt512.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425586_Pc975_Fdir250_v2_rad40_LandPt513.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425587_Pc980_Fdir250_v2_rad40_LandPt513.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425588_Pc985_Fdir250_v2_rad40_LandPt513.xyz
- T:\Qsurge2\modelling\processed_results_SEQ\rad40\v2\TCQld_H2024_no425604_Pc975_Fdir260_v2_rad40_LandPt513.xyz

TC Debbie: Stormtide inundation layer vs. debris line





Limitations

- Does not incorporate shore parallel tracking cyclones but could be added
- Non-linear effects of tide/surge and surge/wave are not considered
- Does not consider riverine or estuarine flooding
- Urban stormwater networks, coastal defenses, and erosion or dune breaching

Challenges

- Validation of the inundation model
- Management and operations: Define responsibilities and roles

Conclusions

- Development of an innovative pilot tool to display storm tide inundation
  -> Multiple dimensions of time
  -> Good spatial resolution (down to 1m)
  -> Tide/wave set up can be added to the surge
  -> Improve consistency of communication of hazard information across districts and states
  -> Reduce complexity of interpreting storm tide warning information

- Enhance Hazard Impact and Risk Service (NHIRS) portal for storm surge impacts

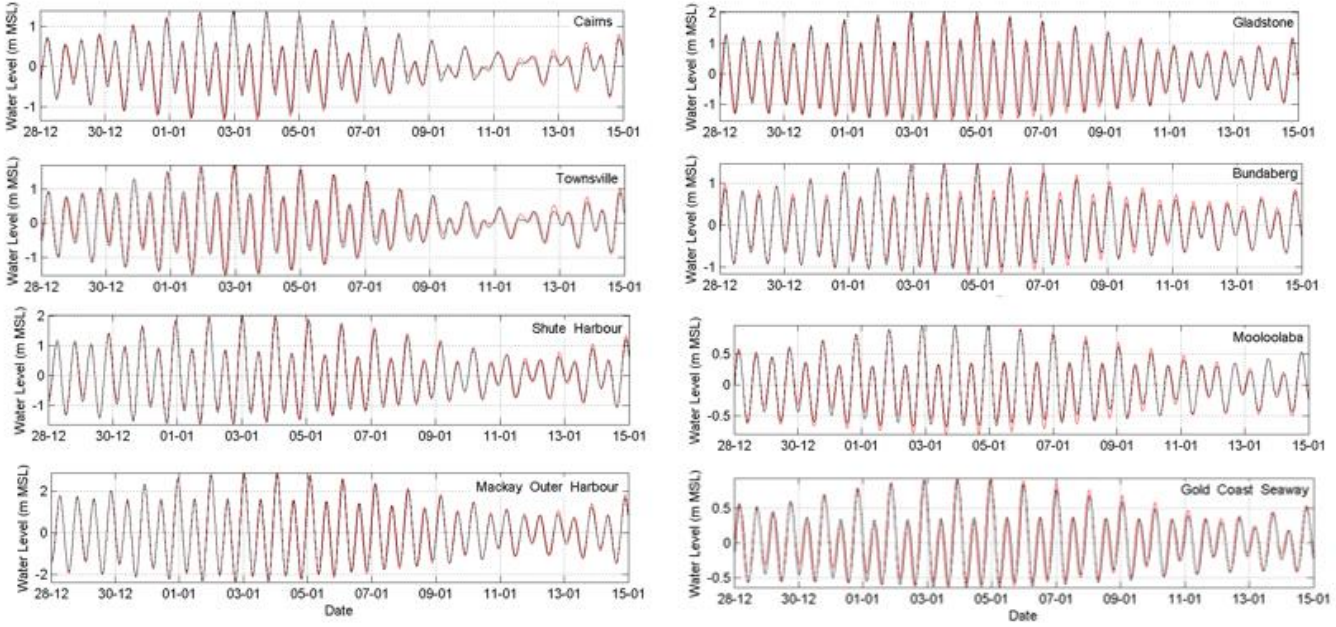
- Tool to be provided to DETSI

Does not replace cyclone forecasting by the BOM or storm surge inundation forecasting


Thank you for your attention
g.faivre@griffith.edu.au

Tidal Calibrations

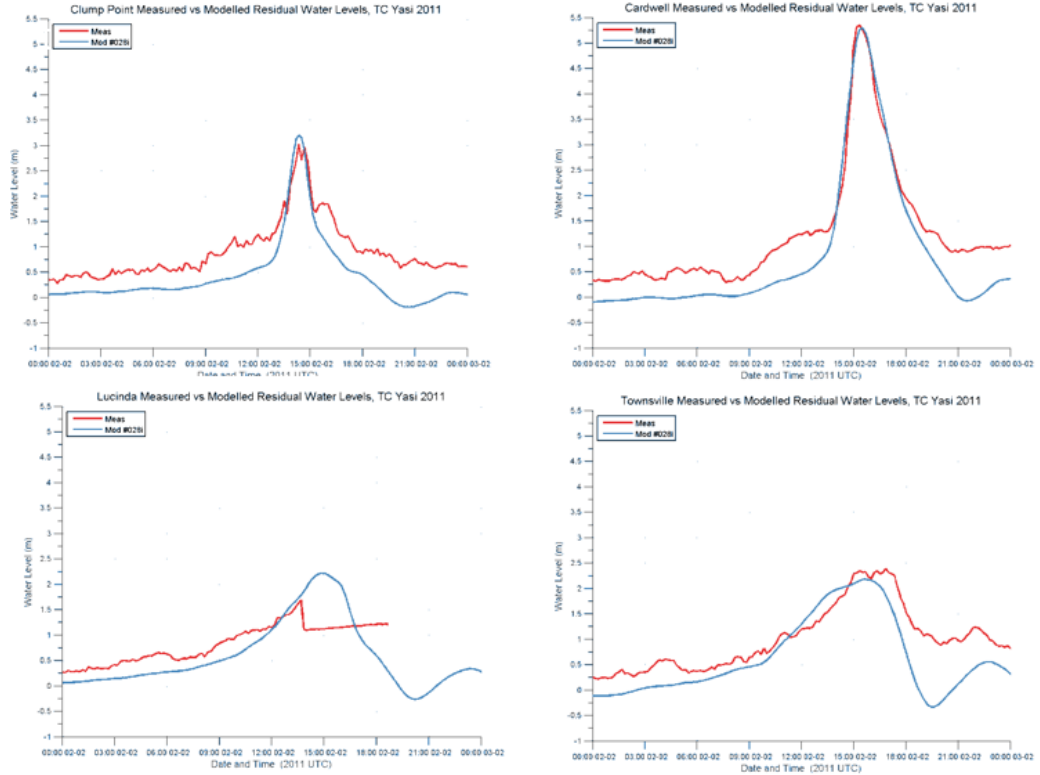
- Excellent tidal calibration for east coast of Qld
- Helps validate model bathymetry and bottom friction



Predicted vs Modelled Tides, Qld Ports

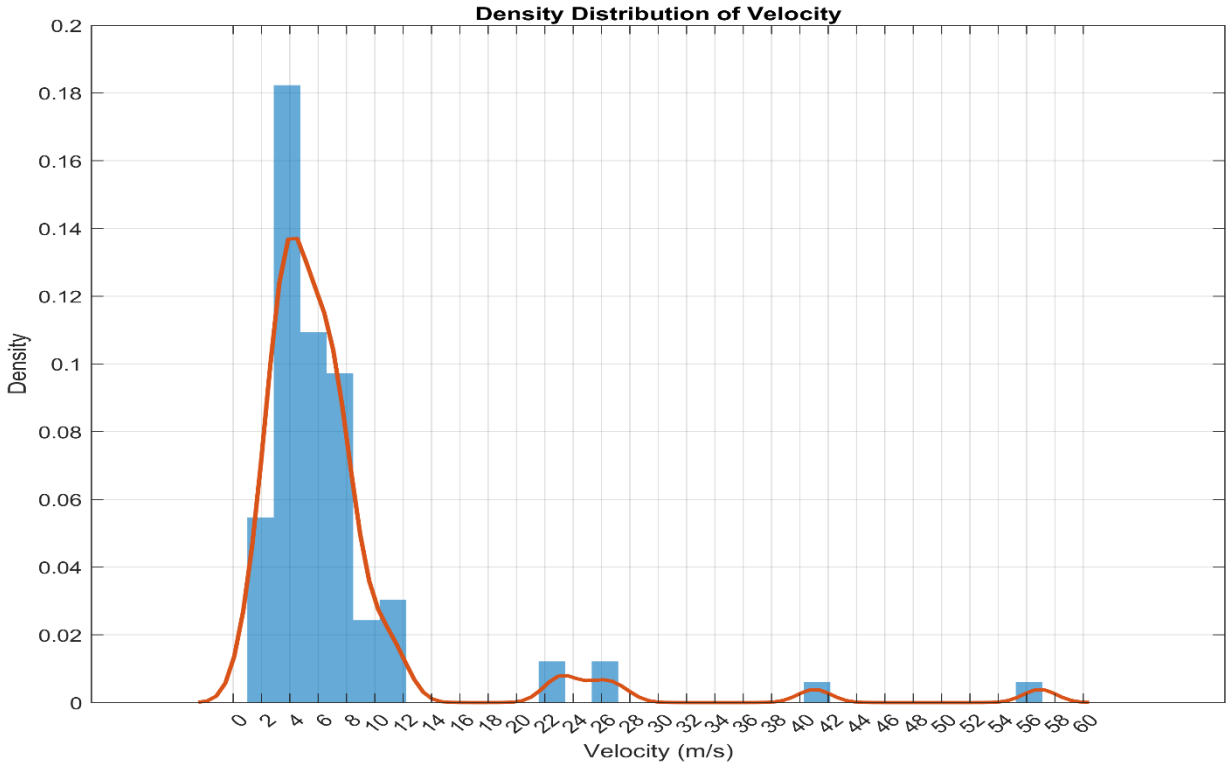
(Burston and Symonds 2013)

Validation: TC Yasi – Holland et al., 2010

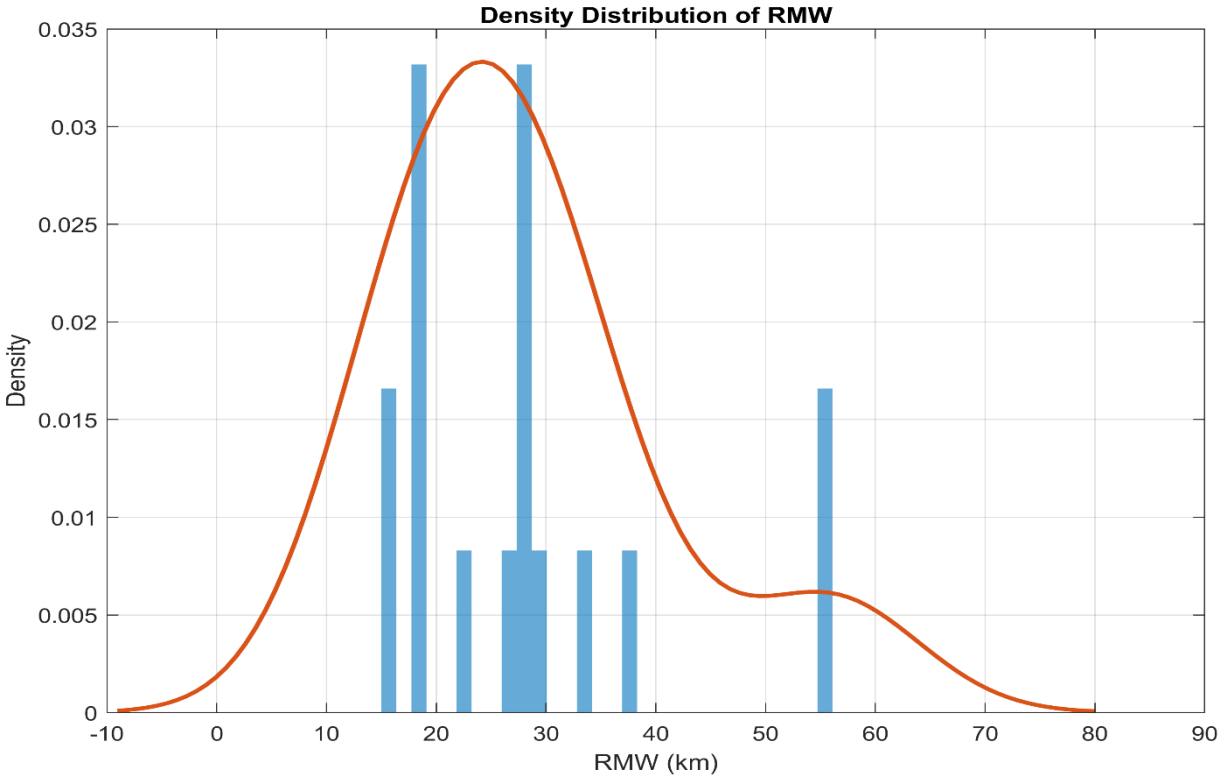


Measured tidal residual (blue) vs modelled storm surge (red): (a) Clump Point, (b) Cardwell, (c) Lucinda and (d) Townsville for TC Yasi.

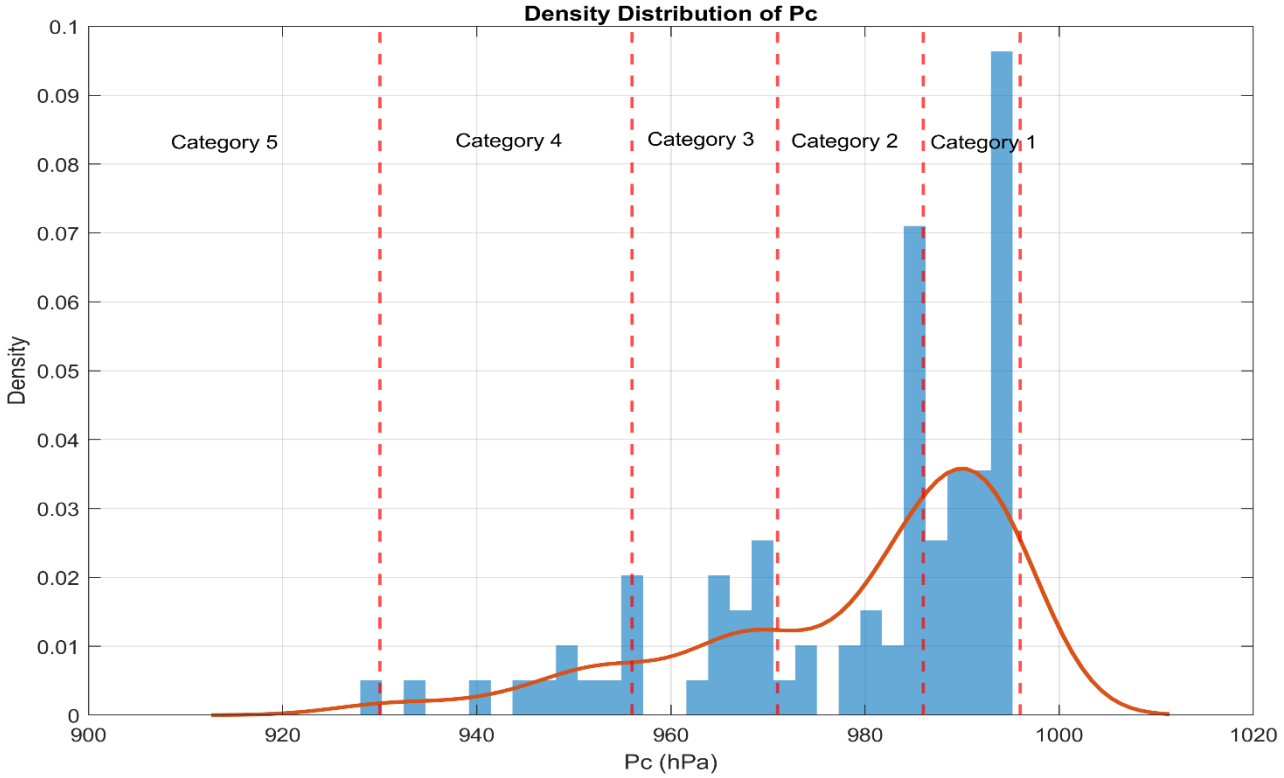
Forward Speed patterns: Density of Distribution (m/s) – Landfall QLD TC, 1908-2024 (noTlows)



Radius of Maximum Wind patterns: Density of Distribution (m/s) – Landfall QLD TC, 1908-2024- noTlows

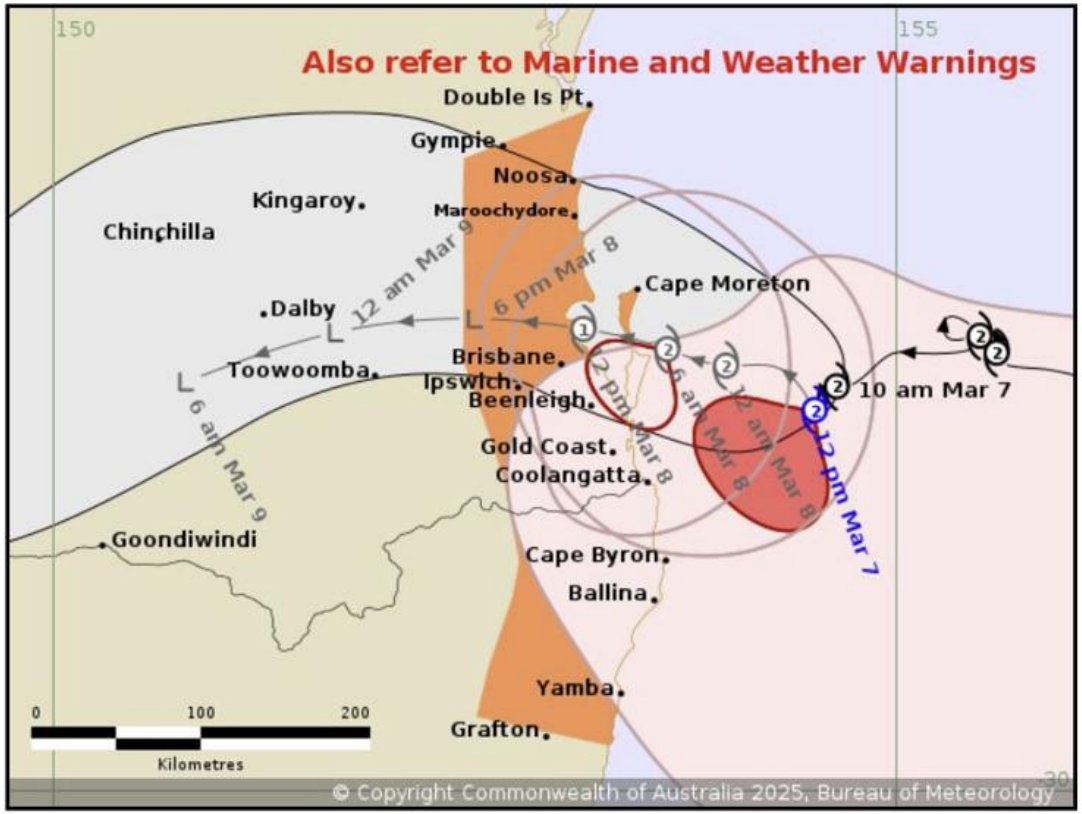


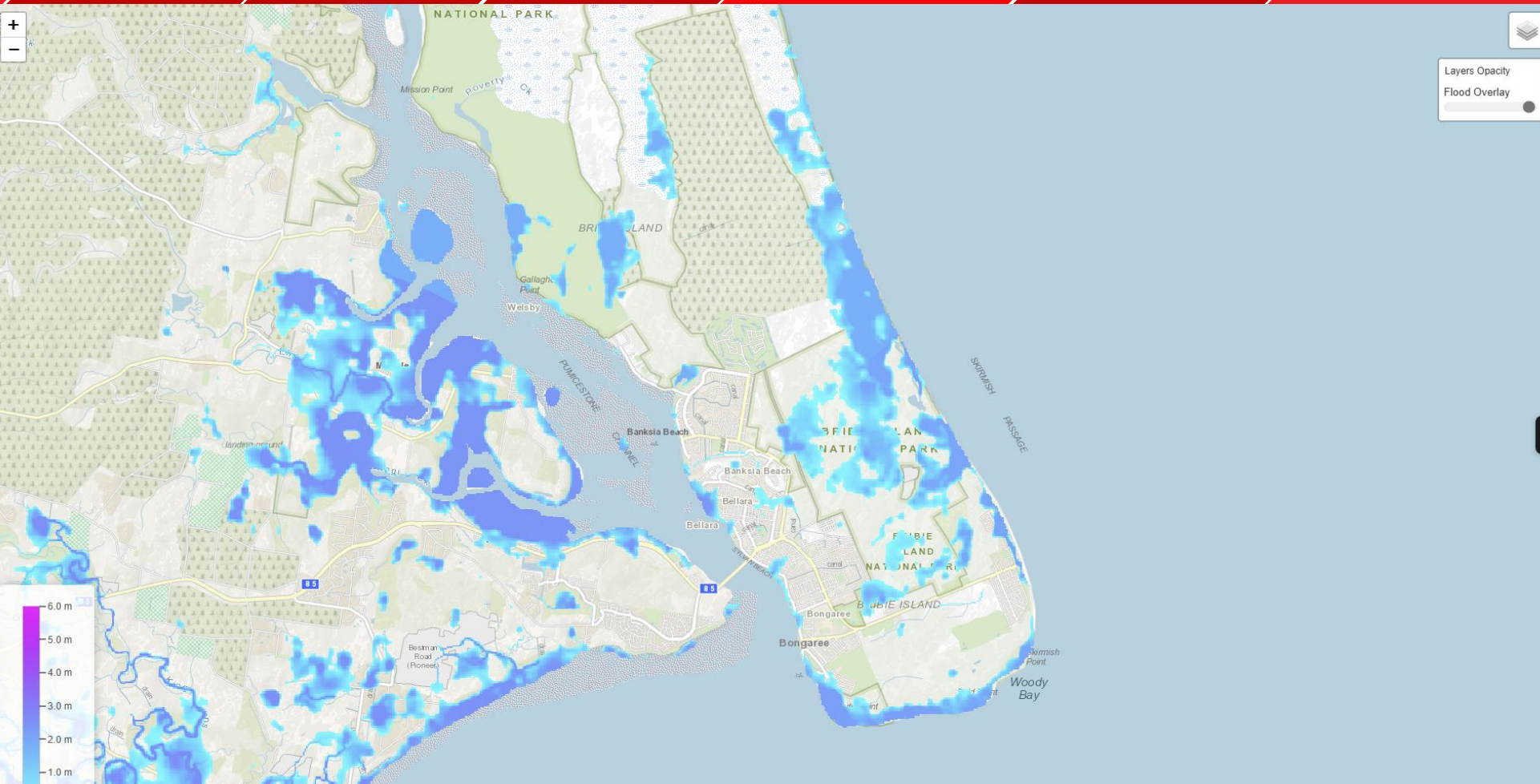
Central pressure patterns: Density of Distribution (m/s) – Landfall QLD TC, 1908-2024- No TLows



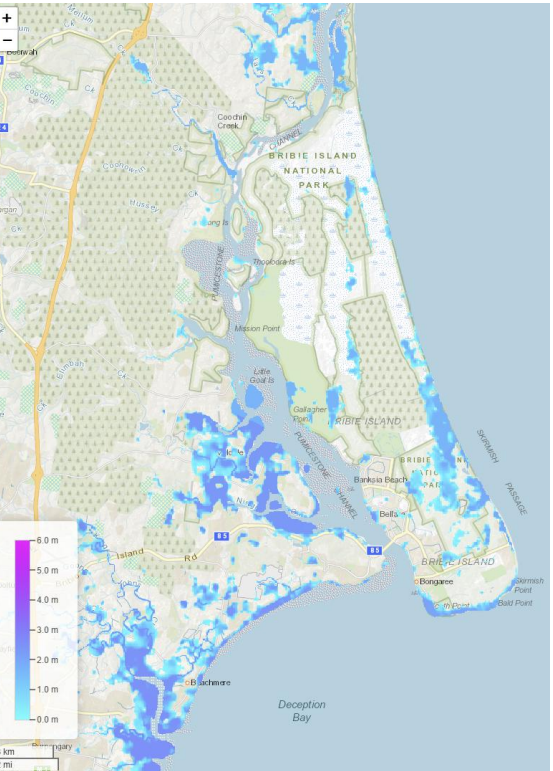
Tropical Cyclone Alfred 22U

Issued at 12:07 pm AEST Friday 7 March 2025. Refer to latest Tropical Cyclone Advice.

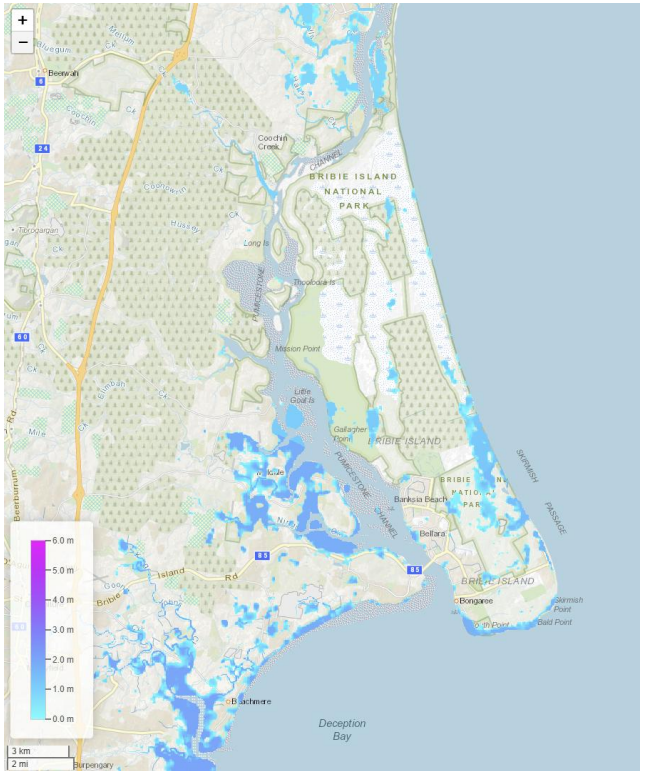



NATIONAL PARK
Mission Point
Poverty Ck
Gallagh Point
Welsby
PUMICESTONE CHANNEL
Banksia Beach
Bellara
SKIRMISH PASSAGE
Bongaree
Woody Bay
Layers Opacity
Flood Overlay
6.0 m
5.0 m
4.0 m
3.0 m
2.0 m
1.0 m

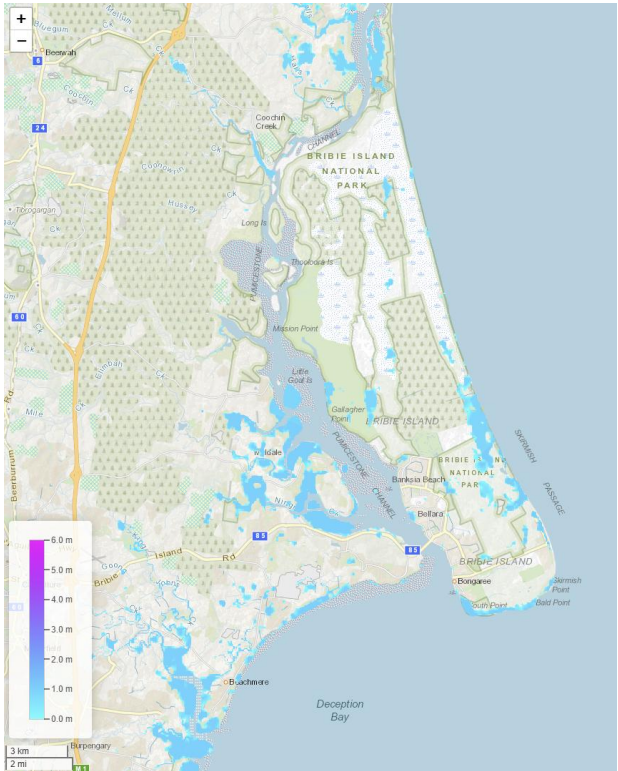
Landfall between Noosa and Beachmere at HAT



Landfall between Beachmere and Courant Island at HAT



Landfall between Courant Island to Coolangatta at HAT



TC Debbie: Stormtide inundation layer vs. Debris lines (5m resolution)