Predicting present and future coastal flood risk in North East Wales

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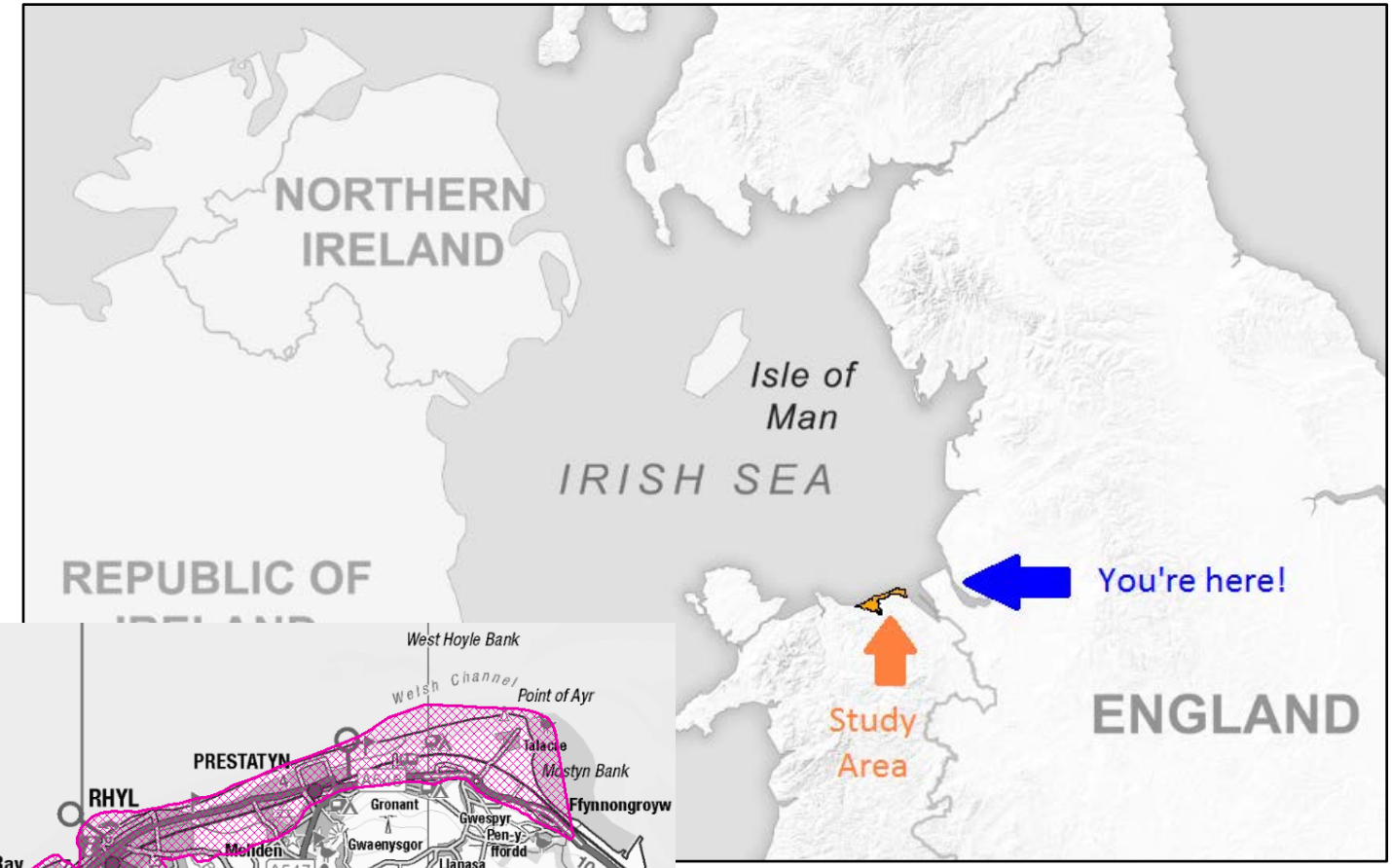
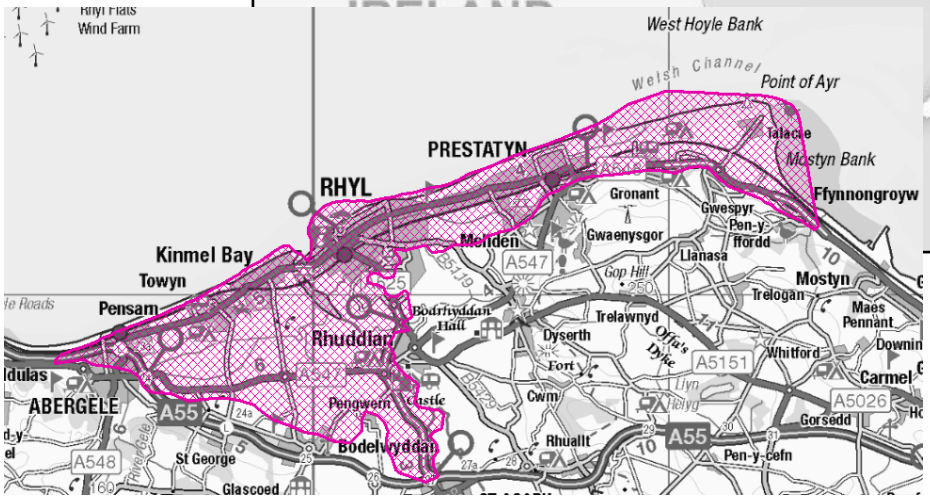
Photo: Craig Colville

North East Wales





Previous flooding

5th December 2013

Peak Offshore Conditions

skew surge = 0.88m

sea level = 5.43mAOD

Hs = 4.58m

Tm = 6.58s

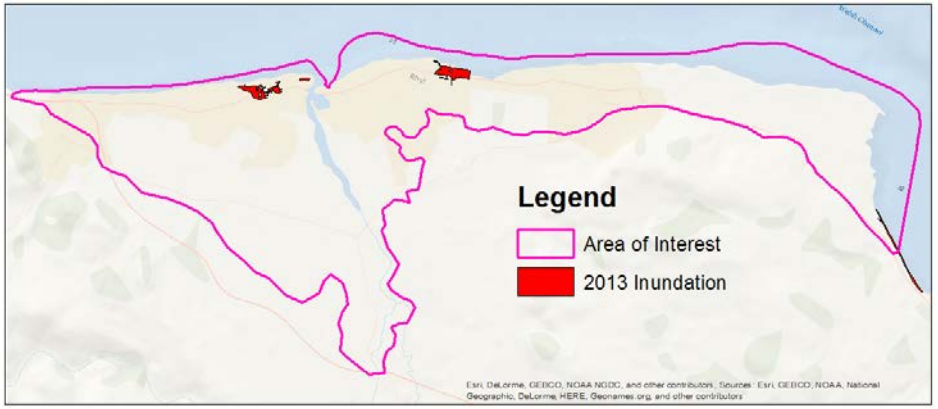
direction = 285°

Damage

- 170 homes flooded
- 400 people evacuated
- 4 casualties
- 5 electrical fires

Photo: Craig Colville

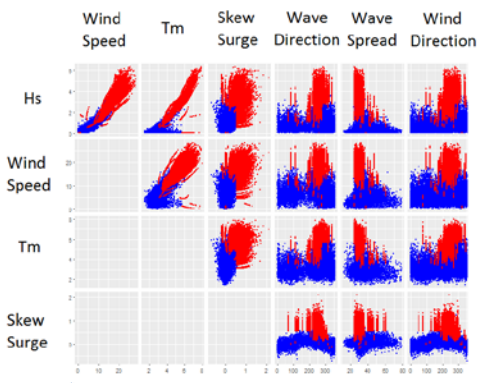
2013 flood maps didn't include the threat from overtopping



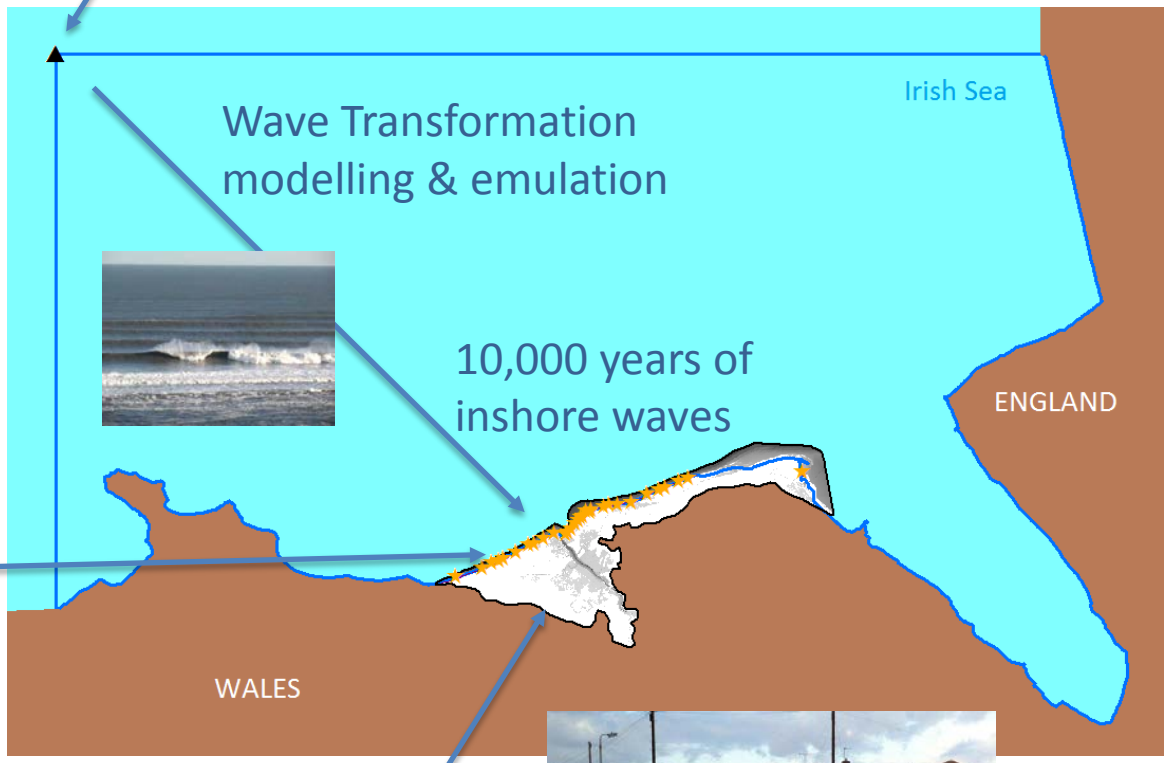
Peak conditions at WaveWatch III point 1516 | water at Rhyl Harbour

New Study

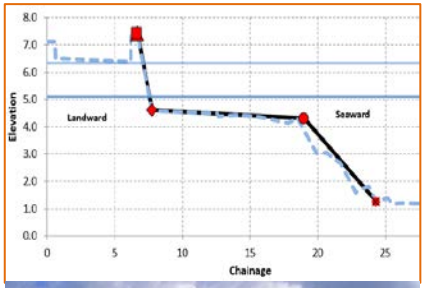
Method



Multi-variate statistical analysis of water levels and offshore wave and wind conditions.
Produce Monte Carlo sample representing 10,000 years



Overtopping



Calculate return periods

Inundation Modelling

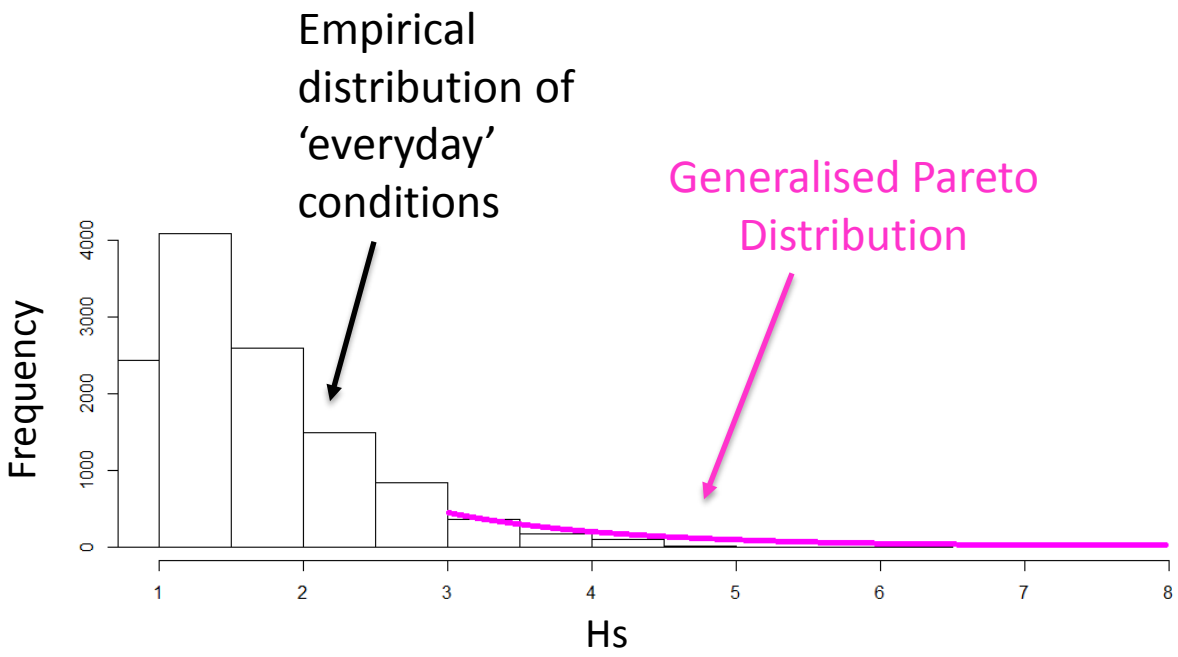
www.bbc.co.uk

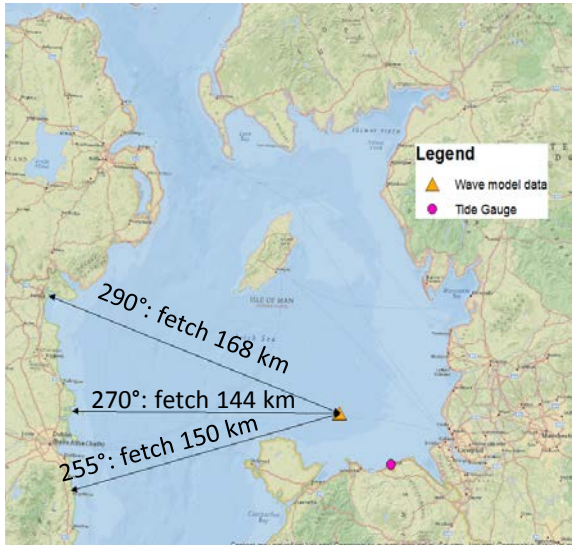
Statistics

Multi-variate statistical analysis

Marginal Modelling: Hs, Tm, wind speed and skew surge

Describe the distribution of each variable independently





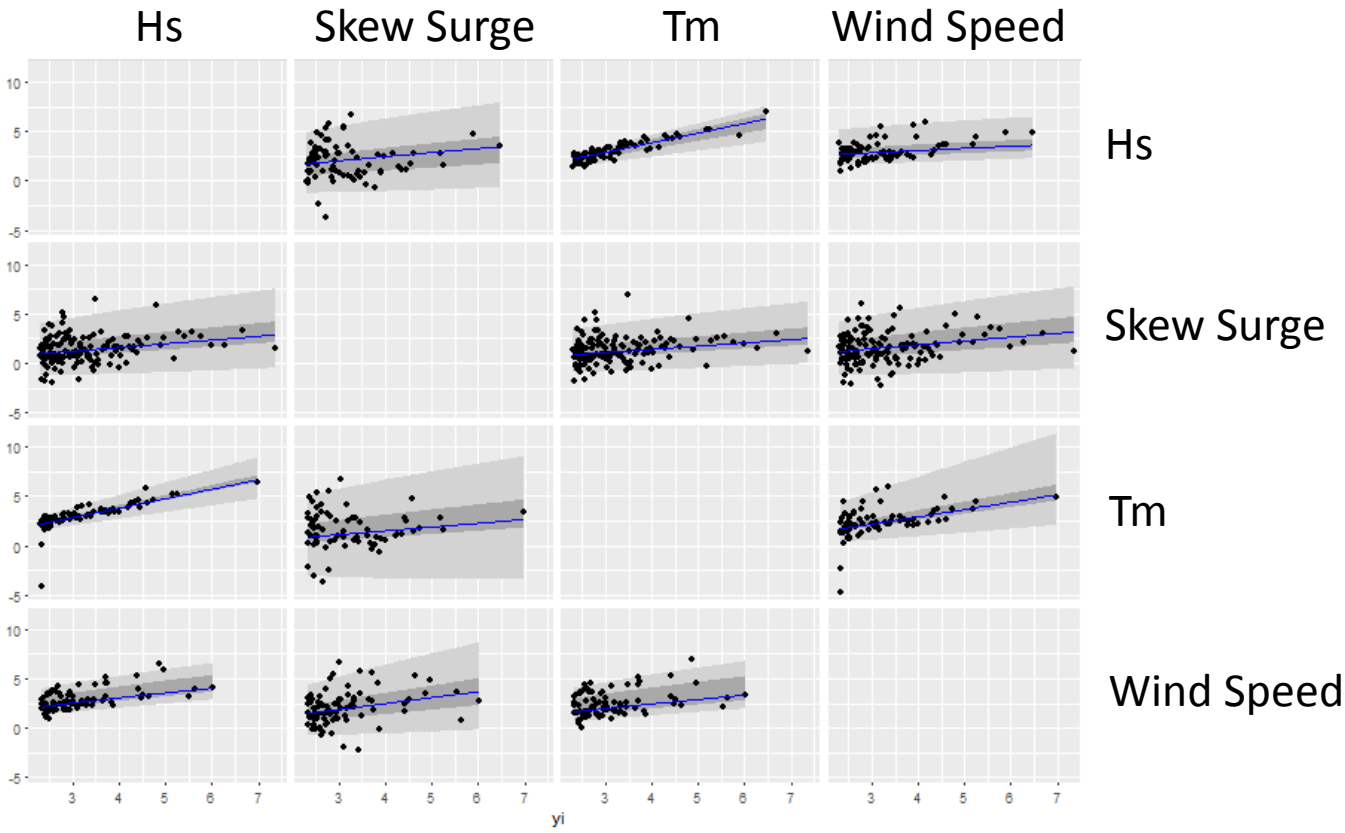
Distributions were fitted so as to replicate the physical limits of this location:

- Wind speed upper end point: bottom of hurricane scale (33 m/s)
- Wave height & period upper end point : consistent with British Standard nomograph

Multi-variate statistical analysis

Dependence Modelling

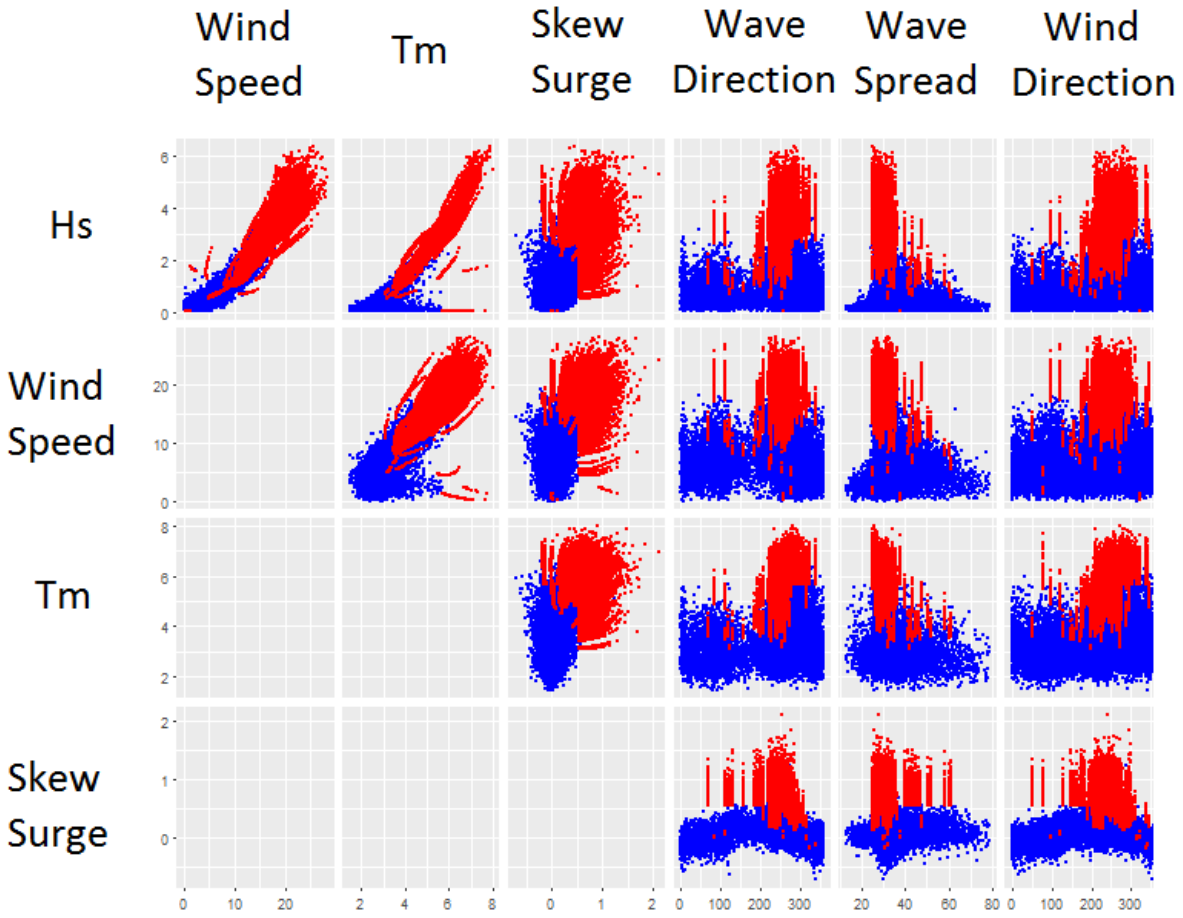
Find the relationship between variables
Used the Heffernan & Tawn dependence model



Multi-variate statistical analysis

Monte Carlo sample

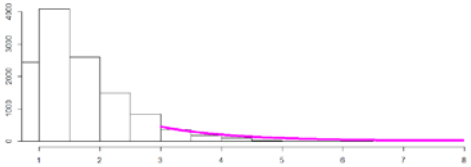
Create a Monte Carlo sample of offshore conditions with the same properties as the observed data. This sample represents 10,000 years.



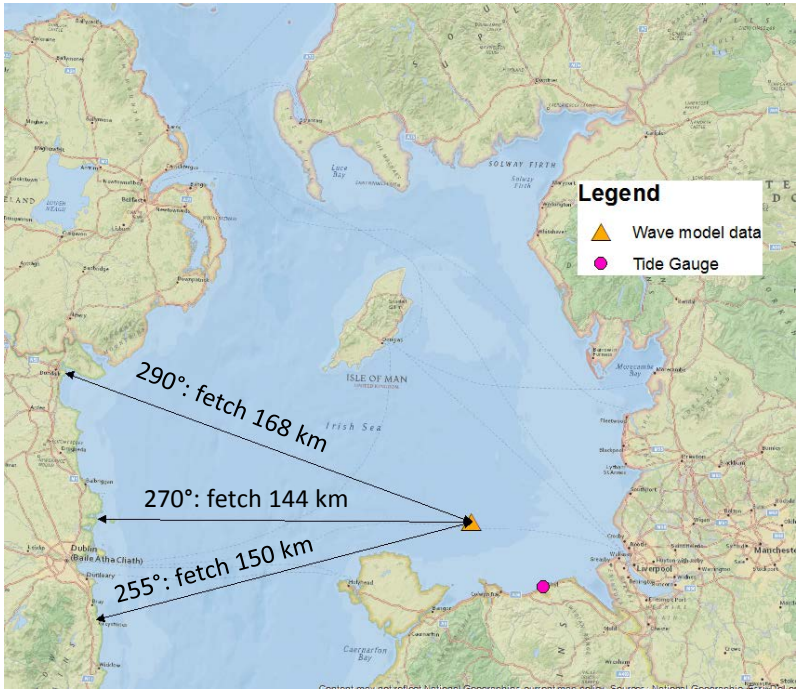
Input data
Monte Carlo Sample

Future Risk: changing offshore climate

- Waves are fetch limited
- Future wave and wind climates were not changed



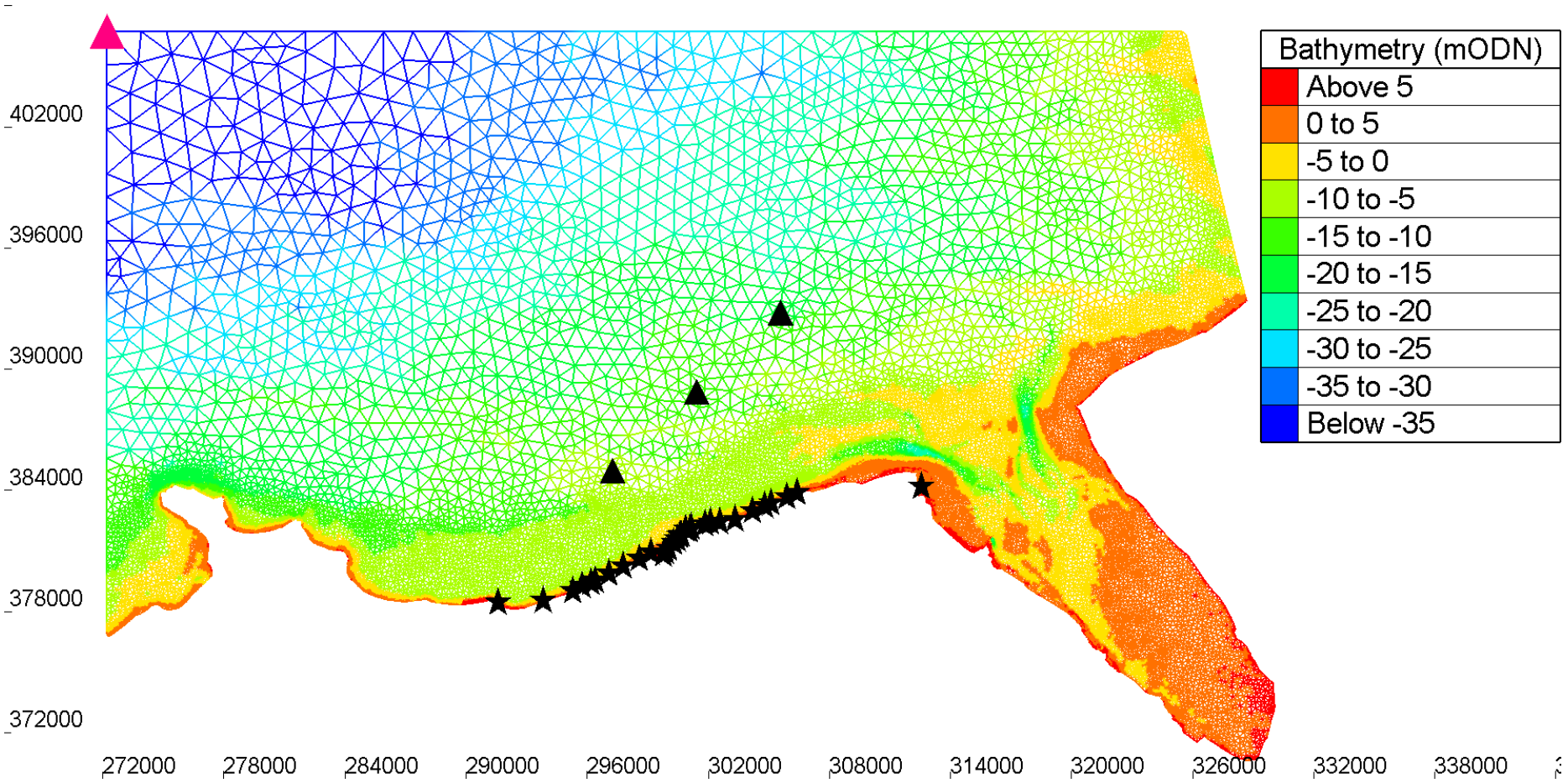
- Sea level rise applied before waves were transformed into the nearshore



Epoch	2017	2067	2092	2117
MSL increase (m)	0	0.41	0.71	1.08

Numerical Modelling

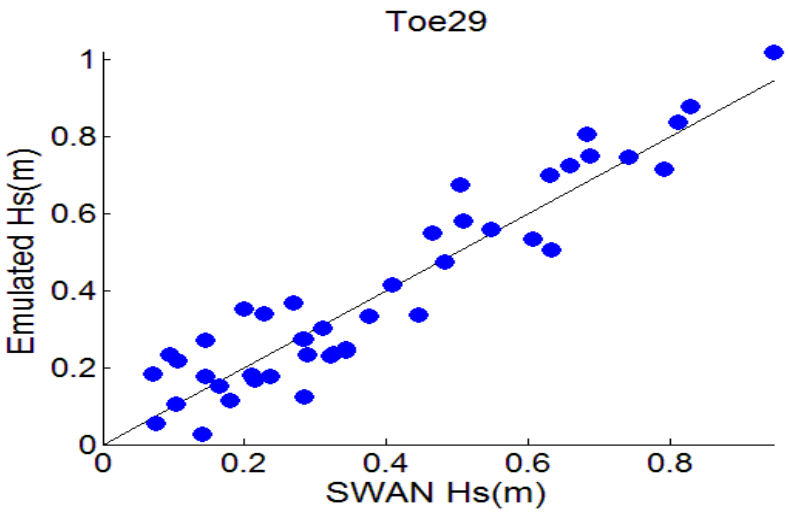
Wave Transformation Modelling



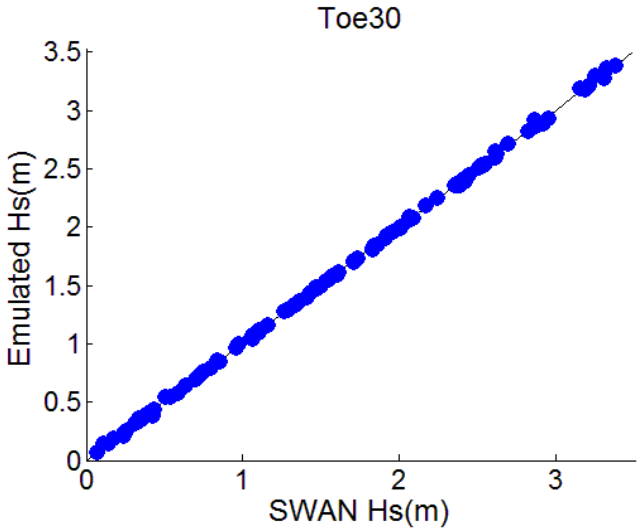
- SWAN
- Spatially varying water level grid
- ‘Calibrated’ against RADAR observations

Wave Emulation

- Offshore dataset represents 10,000 years includes 172,342 events
- Simulated 800 events with SWAN
- Used emulators to, transform the remaining events into nearshore conditions



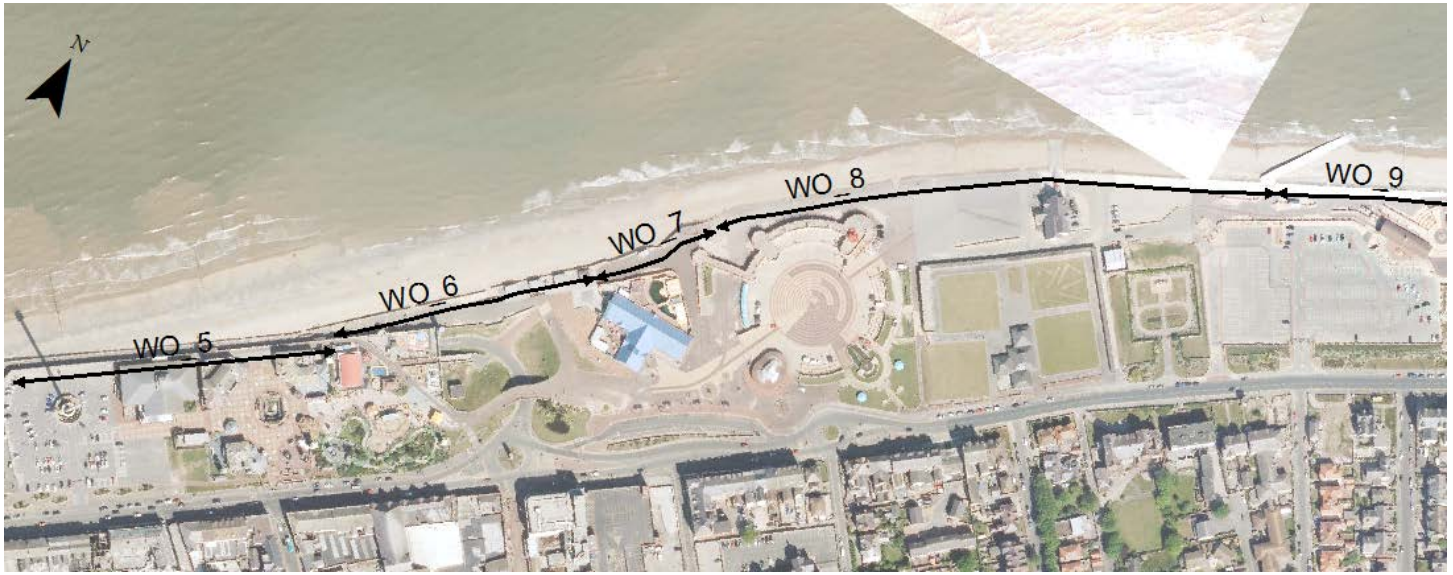
WORST



BEST

Wave Overtopping

- Split coastline into 32 sections with similar defence and wave characteristics
- Calculated overtopping using Neural Network
- Calibration against flood history: hindcast



Wave Overtopping: Hindcast

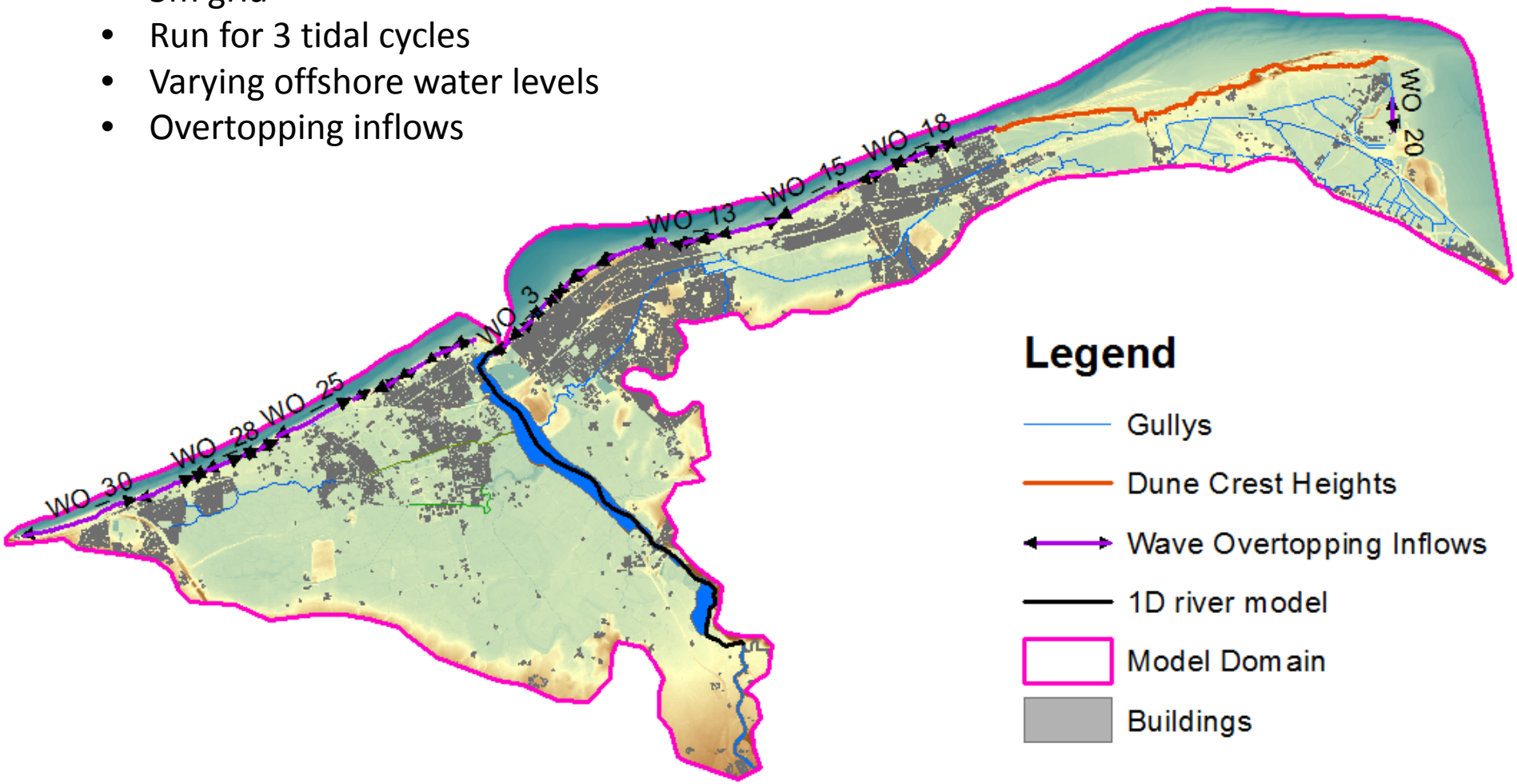
Image: google.co.uk

Wave Overtopping: validation

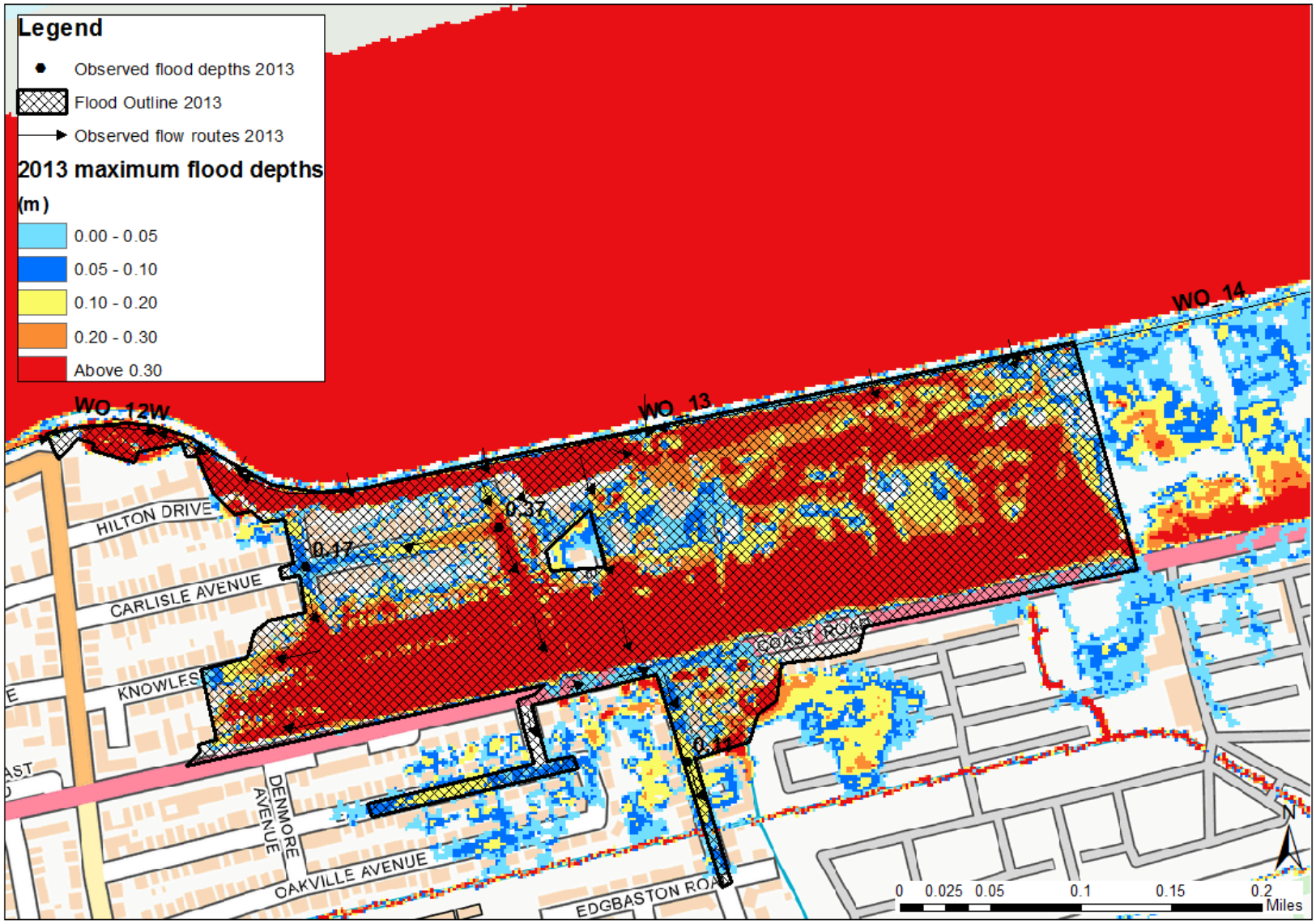
Denbighshire County Council CCTV

Inundation Modelling

- TUFLOW and Flood Modeller (ISIS) coupled
- 2D finite difference – 1D river model
- 5m grid
- Run for 3 tidal cycles
- Varying offshore water levels
- Overtopping inflows



Simulation of 5th Dec 2013

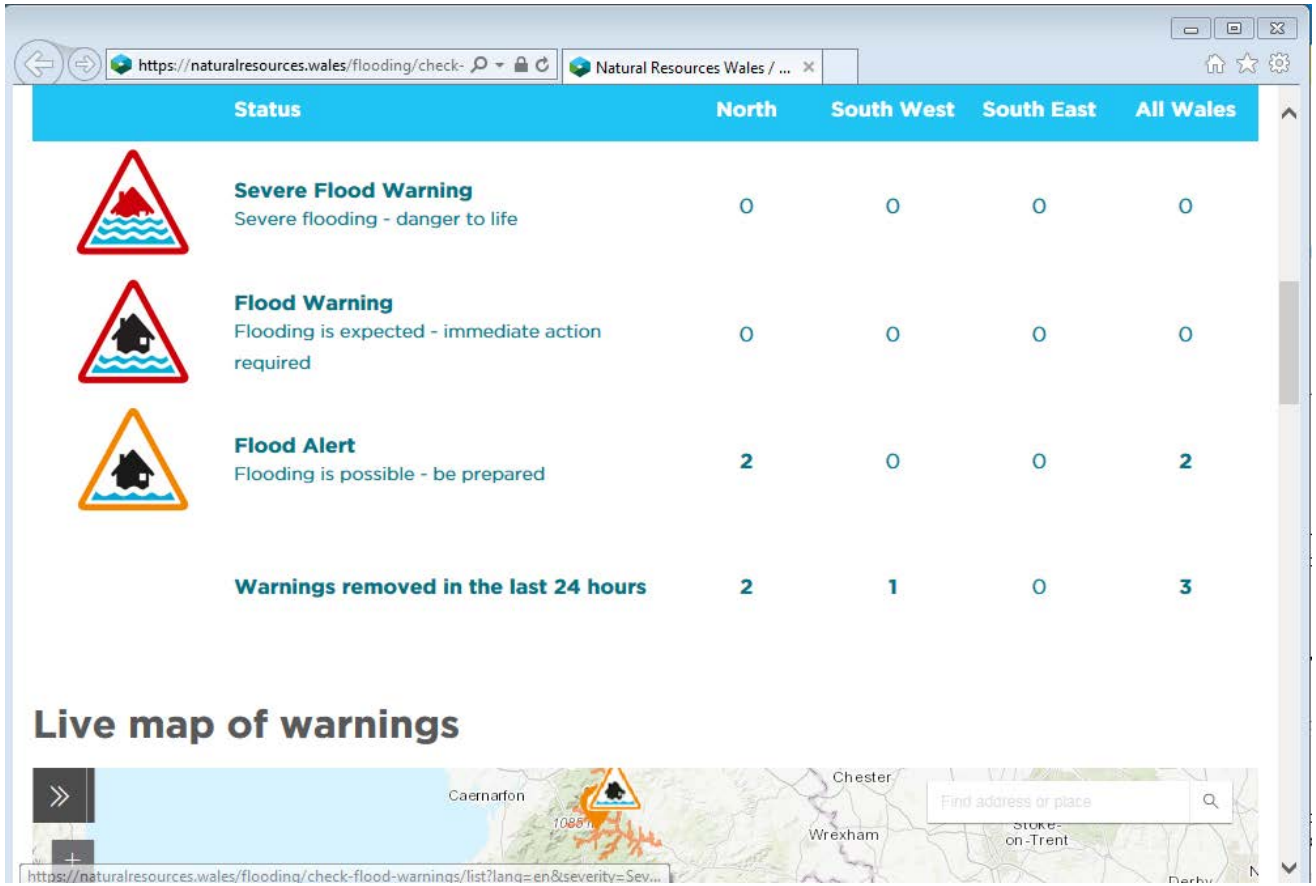


Using the results to manage flood risk

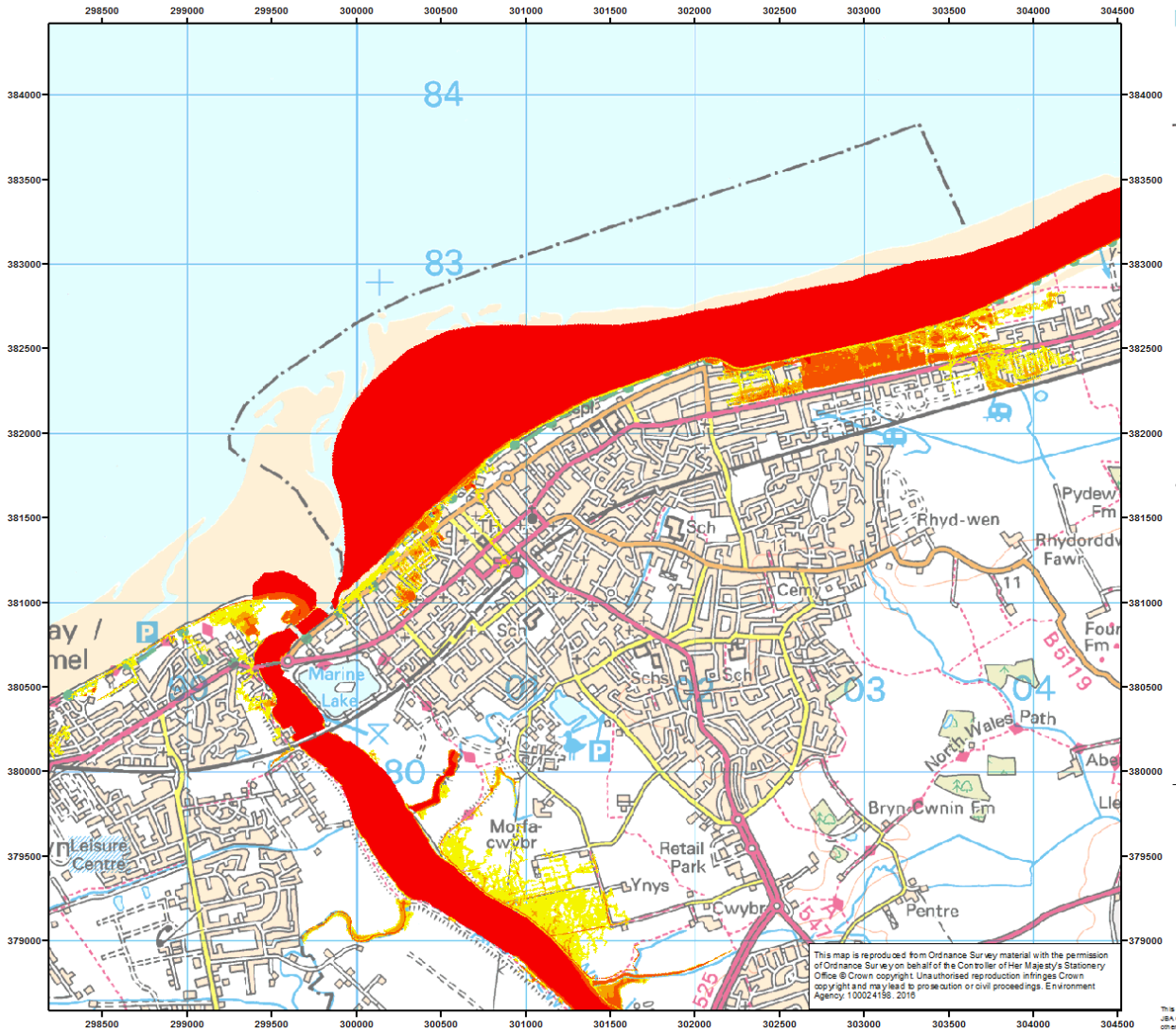
Managing coastal flood risk

- Study results will be used to update NRW flood warning and alert thresholds and areas

- The study outputs will also be used inline with Planning Policy Wales to prevent inappropriate development on the flood plain



Coastal Hazard Maps



ForeCoast® JVis

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JBA consulting

Date	14th September 2017	
Wave Height	5.34	m
Wind Direction	299	°
Wind Speed	22	m/s

WATER LEVEL

Best forecast	5.34	m AOD*
Worst case		m AOD*

PROPERTIES AT RISK

Best forecast	1211
Worst case	

Mapped Outputs

DEPTH | HAZARD | VELOCITY

- PROPERTIES
- FLOOD WARNING AREAS
- CRITICAL INFRASTRUCTURE
- FLOOD ZONE 2

Legend

Hazard

- < 0.75 - Caution - shallow flowing water or deep standing wate
- 0.75 - 1.25 - Danger for some (children and elderly)
- 1.25 - 2.00 - Danger for most (including the general public)
- > 2.00 - Danger for all (including emergency services)

Questions?

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