# Background to the Review of Tsunami Hazard

**Presented by William Power**

**Contains the work of many authors**

# Tsunami Hazard Review 2013 Update

Contains chapters summarising:

- Historical tsunami in New Zealand
- Geological evidence for tsunami
- Damage that a tsunami could cause
- Tsunami sources that threaten New Zealand
- Tsunami modeling methods

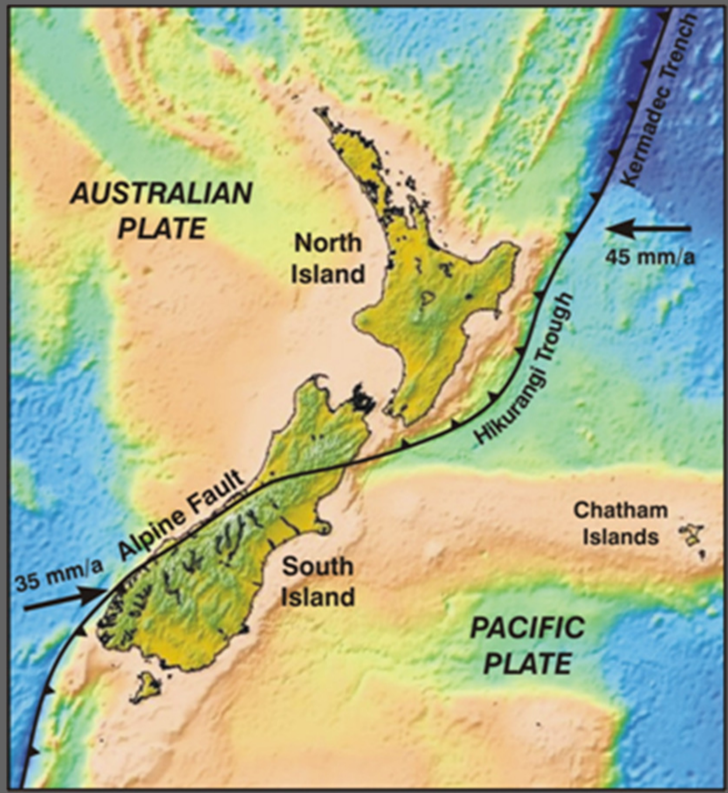
The review also presents results from a probabilistic model that estimates the level of tsunami hazard to all parts of the country

# New Science: illustrated by the Tohoku tsunami

- **The earthquake was larger than anticipated, Mw9.0 where an Mw~8.0 had been expected.**

- **A possible predecessor occurred in AD 869**

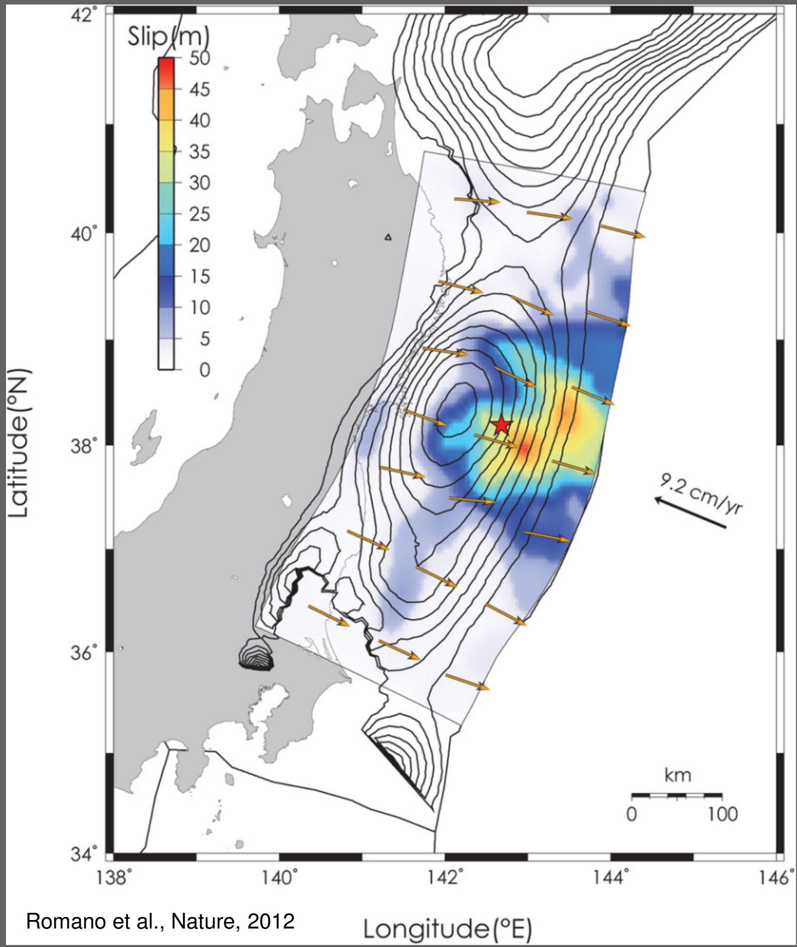
# Implications




- We can infer little from our ~200 year recorded history about what the possible size of the largest earthquakes on our subduction zones
- Need to use Paleotsunami, Paleoseismic data, and rethink geophysical assumptions

# More new science

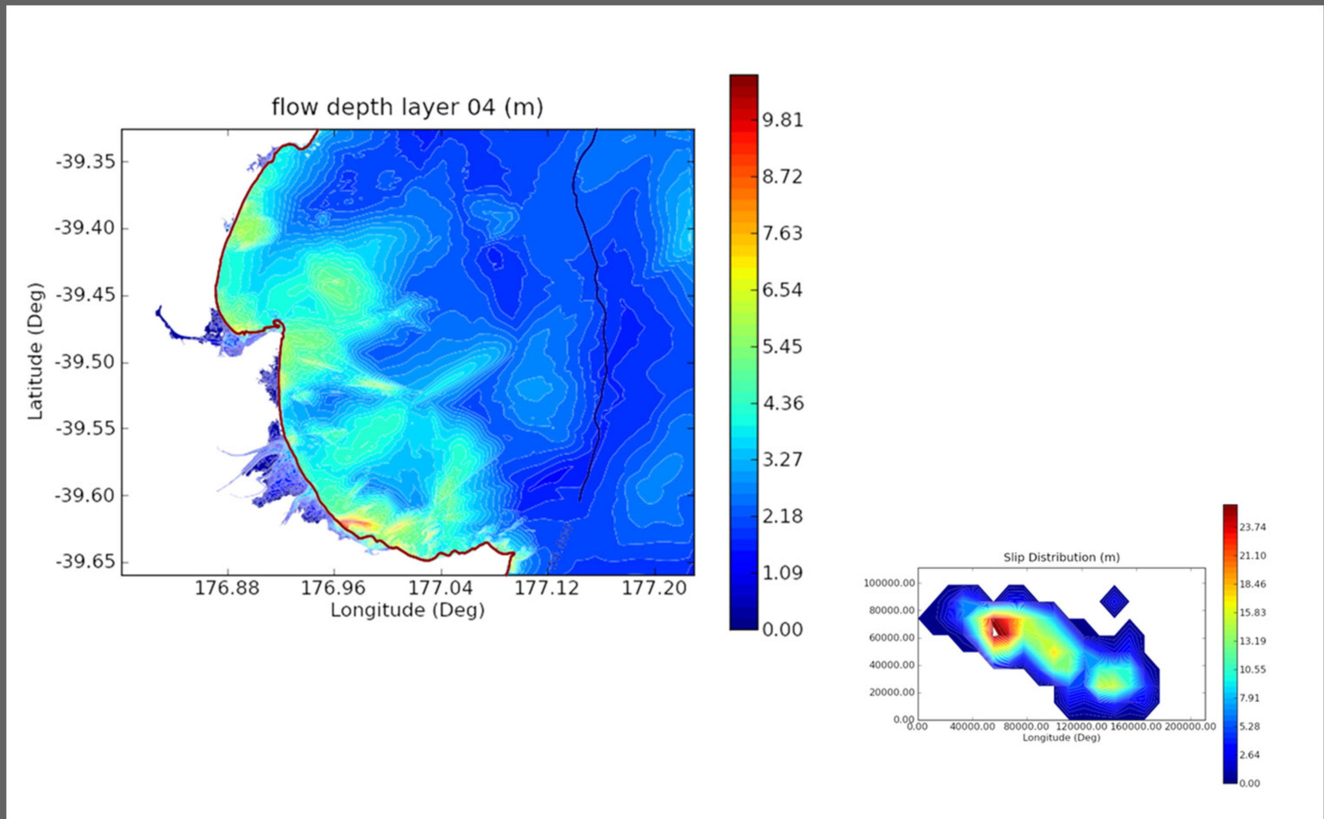
- **Movement on the fault was very non-uniform**
- **The tsunami is strongly affected by this non-uniformity**

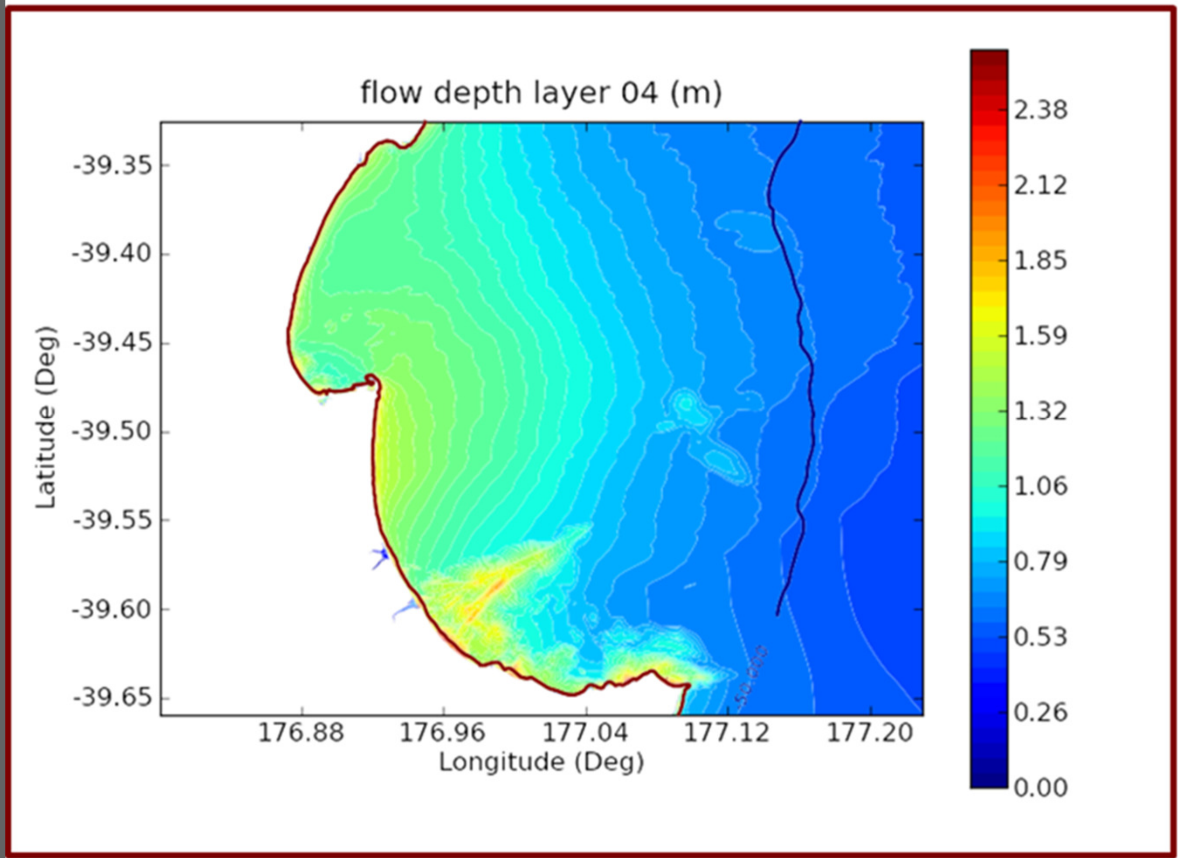



Romano et al., Nature, 2012

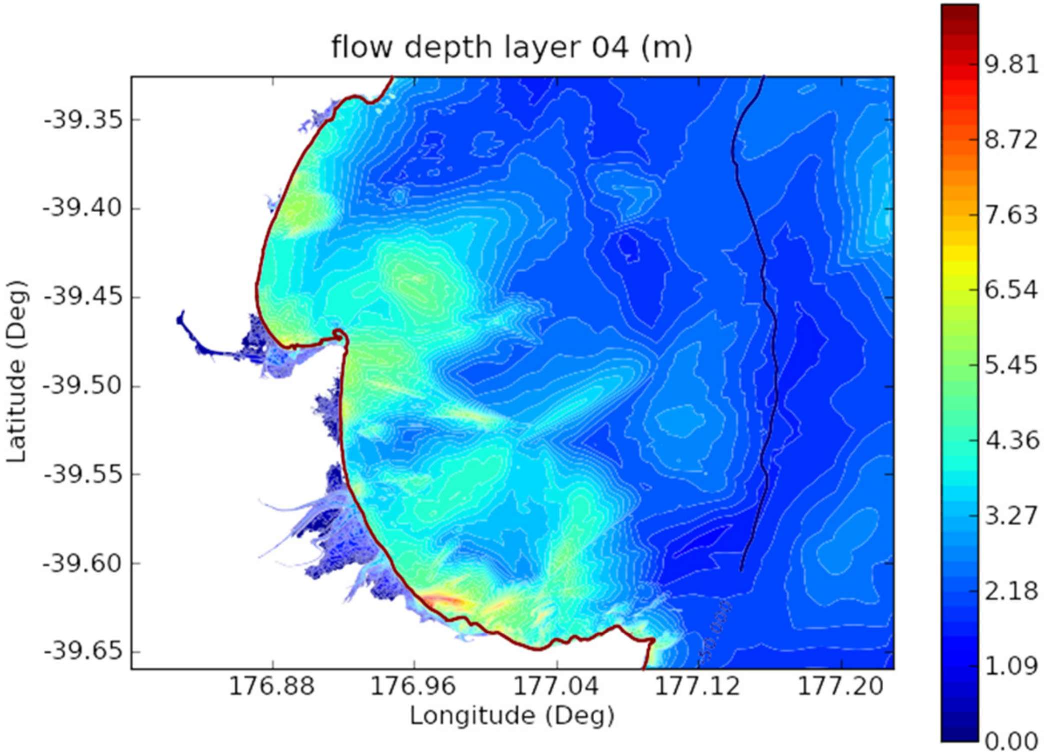
# Implications

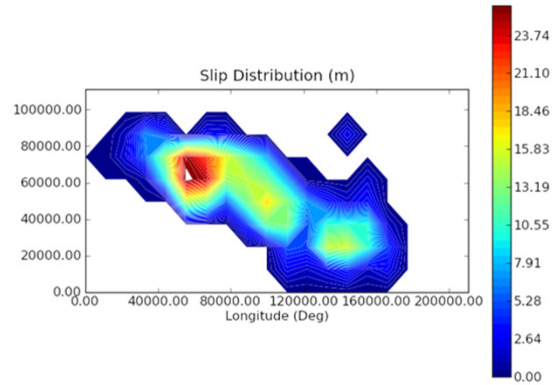
**We are discovering that non-uniform slip can make a significant difference to tsunami hazard in New Zealand towns close to the plate interface**



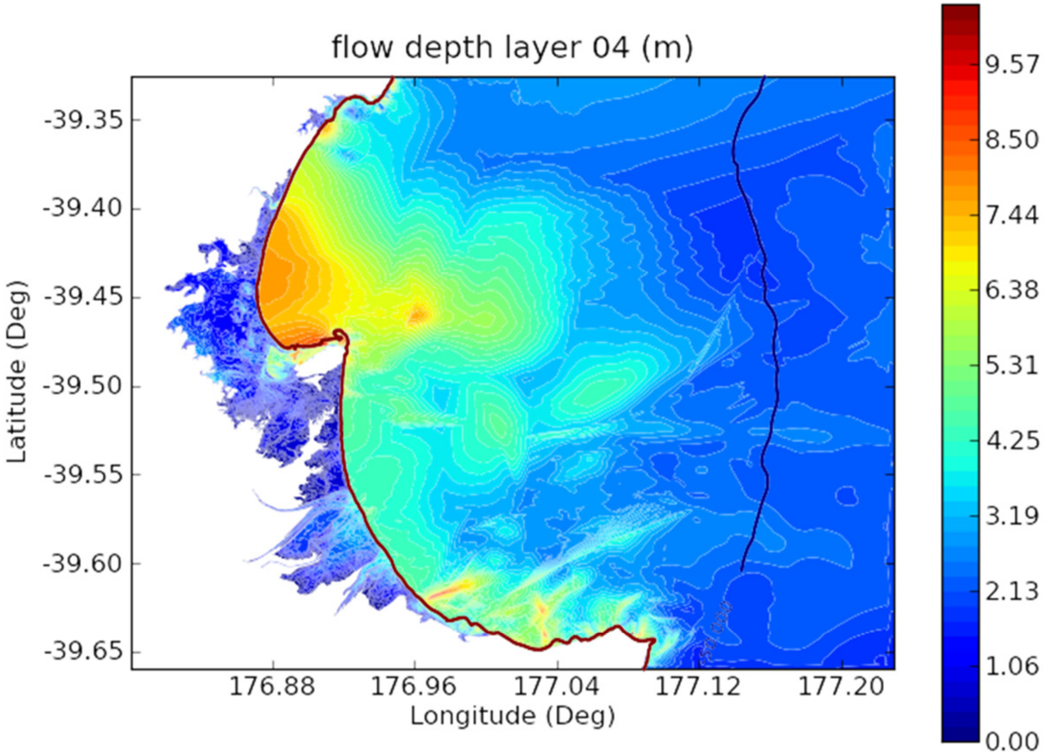


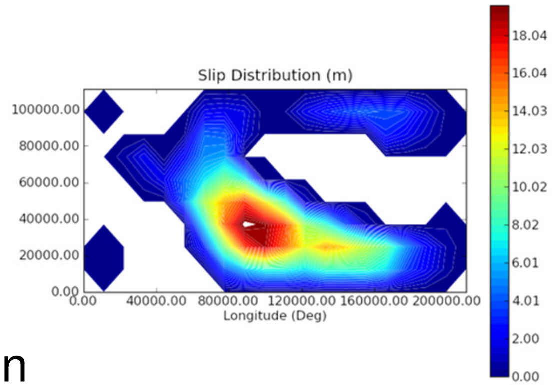

Mw 8.4 uniform slip



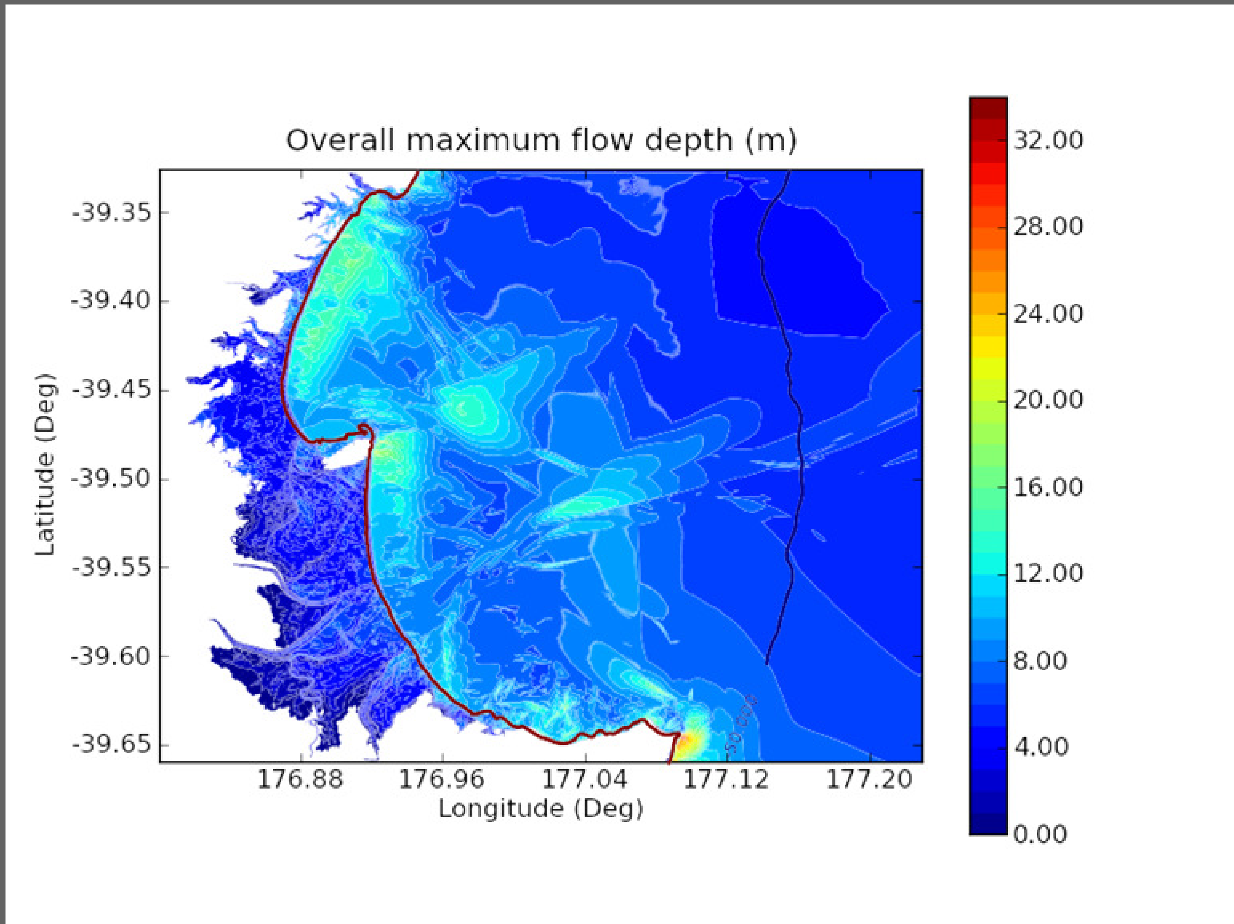




Mw 8.4 non-uniform slip, one possible distribution

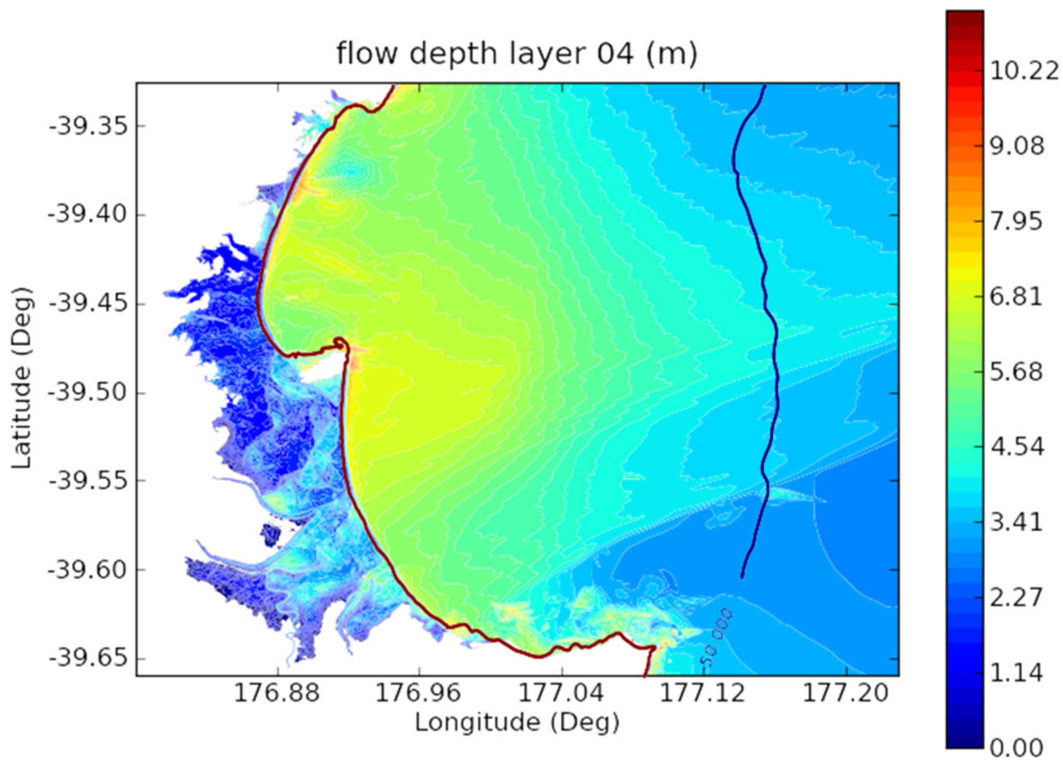



Mw 8.4 non-uniform slip, another possible distribution

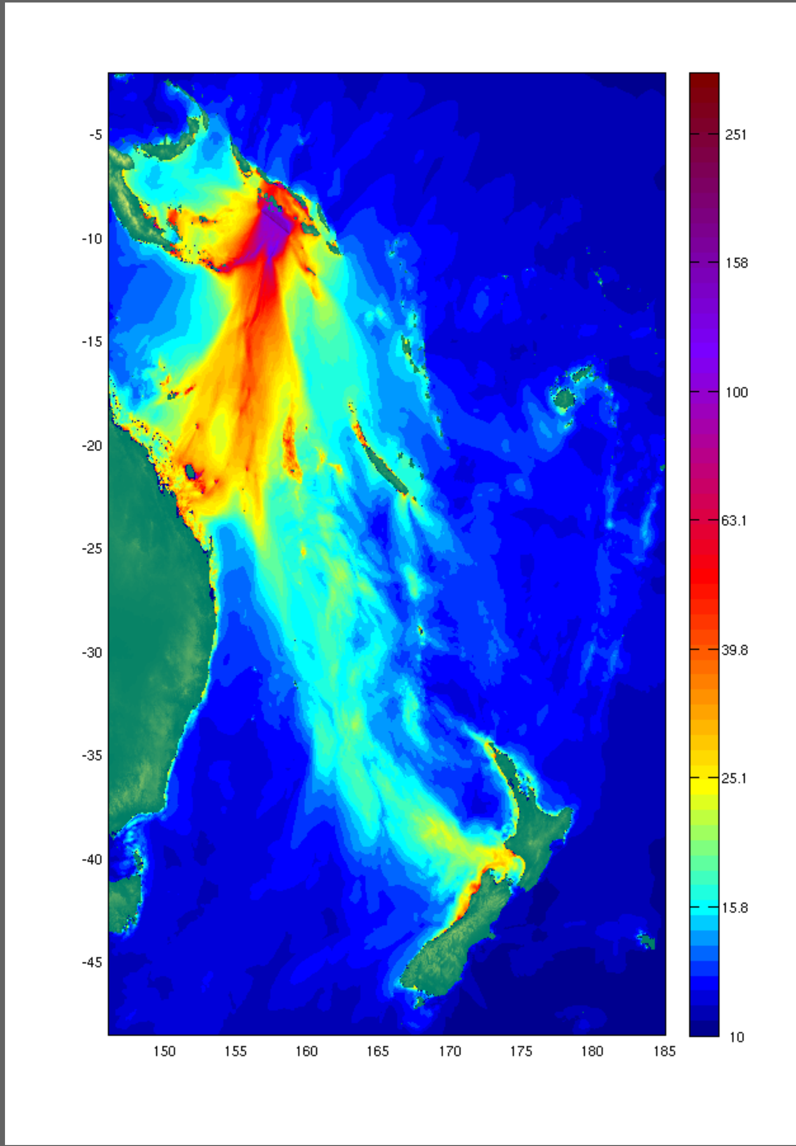



Mw 8.4 non-uniform slip, overlaying 60 possible distribution




Constant slip: Mw = 8.91

# Awareness of new sources that affect NZ

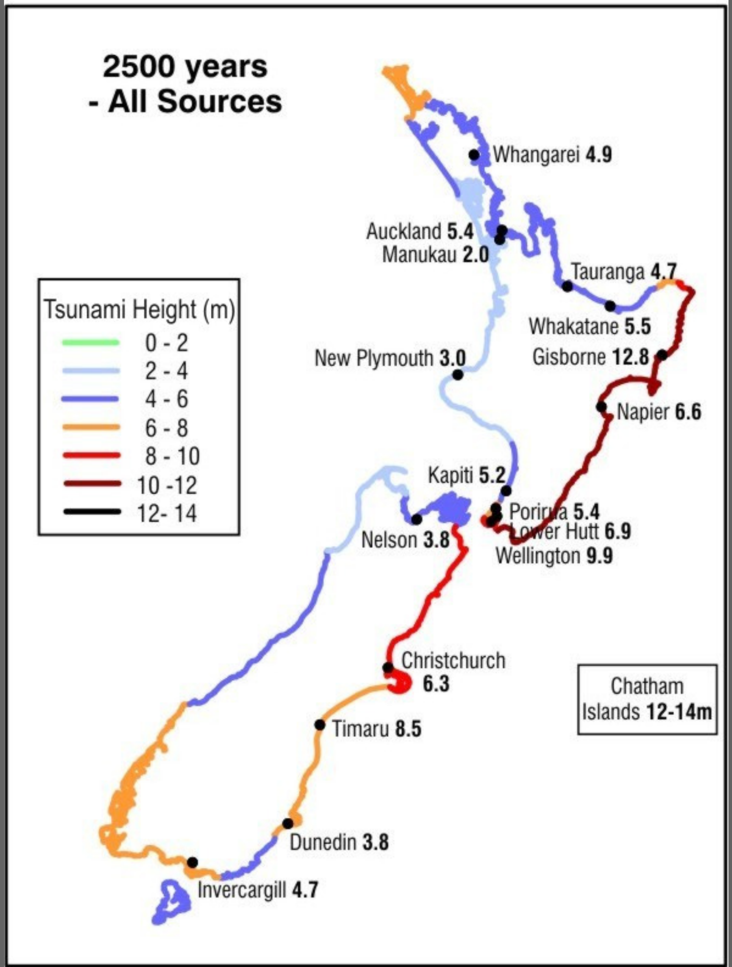


# Tsunami Hazard model 2013 update

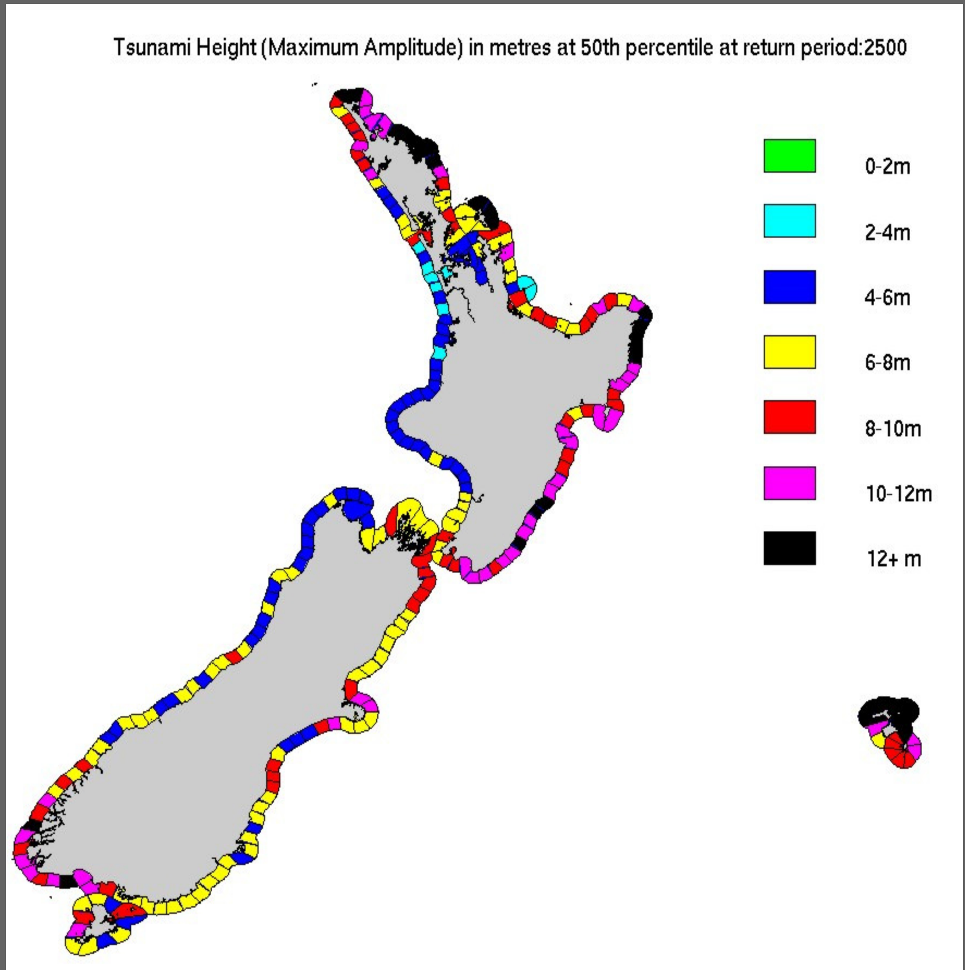
- Updated earthquake probabilities for distant earthquakes, and wider set considered
- Updated earthquake probabilities for local sources, encompassing NZSHM
- Much improved modelling of local subduction zones
- Improved modelling of distant subduction zones
- Unchanged modelling of other local faults
- First attempt at accounting for non-uniform slip
- Added nationwide coverage

# National overview

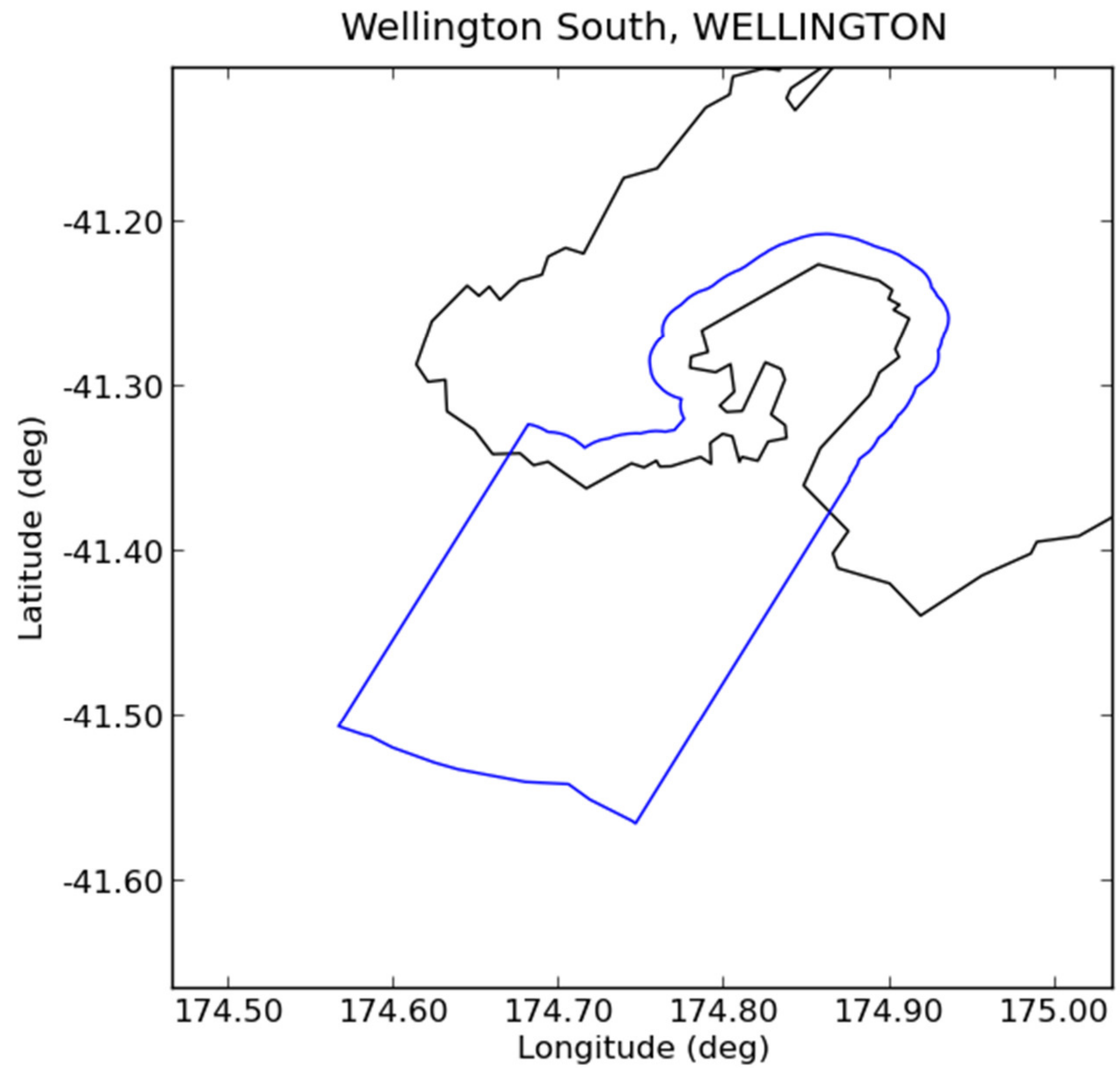
2005

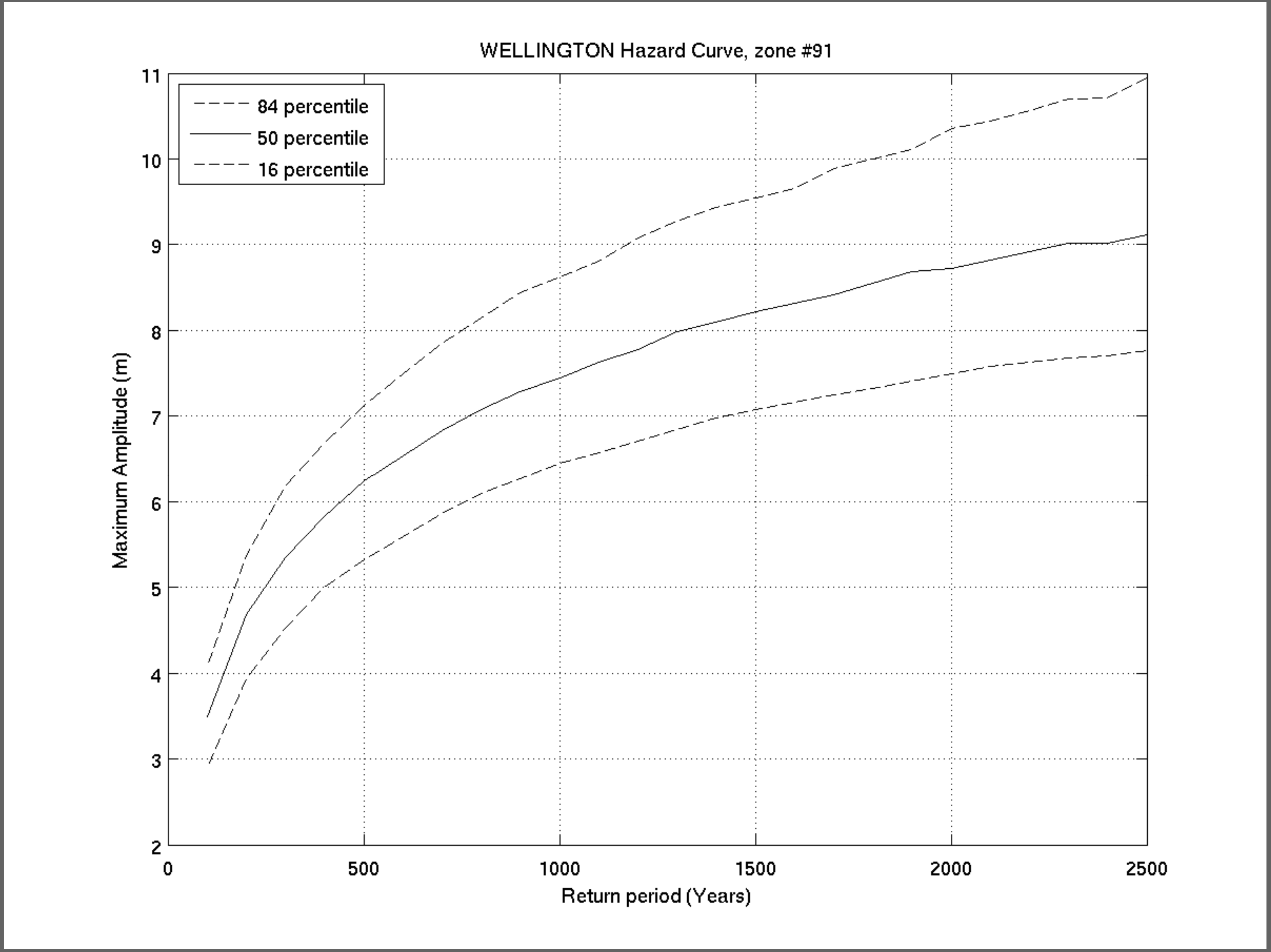



2013

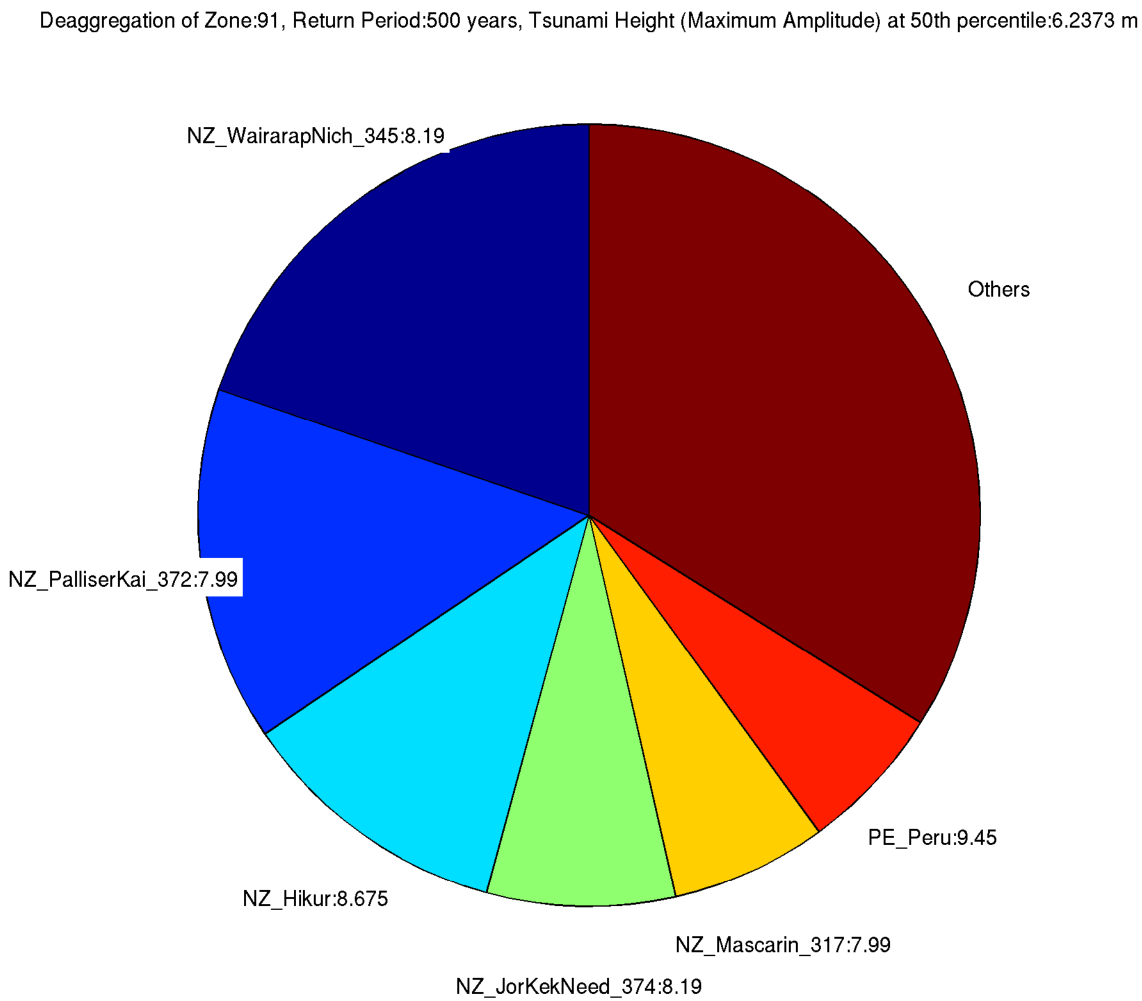



Also at 100 and 500 years, and different confidence levels

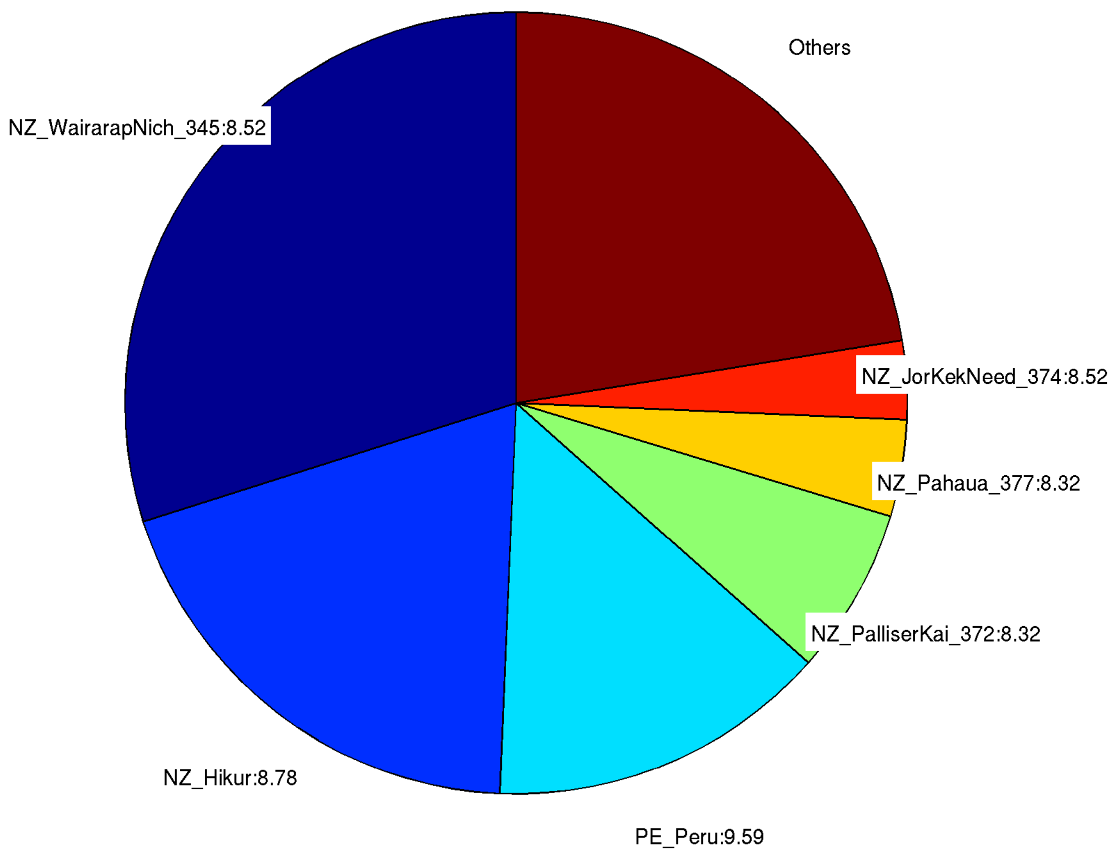

Wellington South, WELLINGTON
-41.20
-41.30
-41.40
-41.50
-41.60
Latitude (deg)
174.50
174.60
174.70
174.80
174.90
175.00
Longitude (deg)

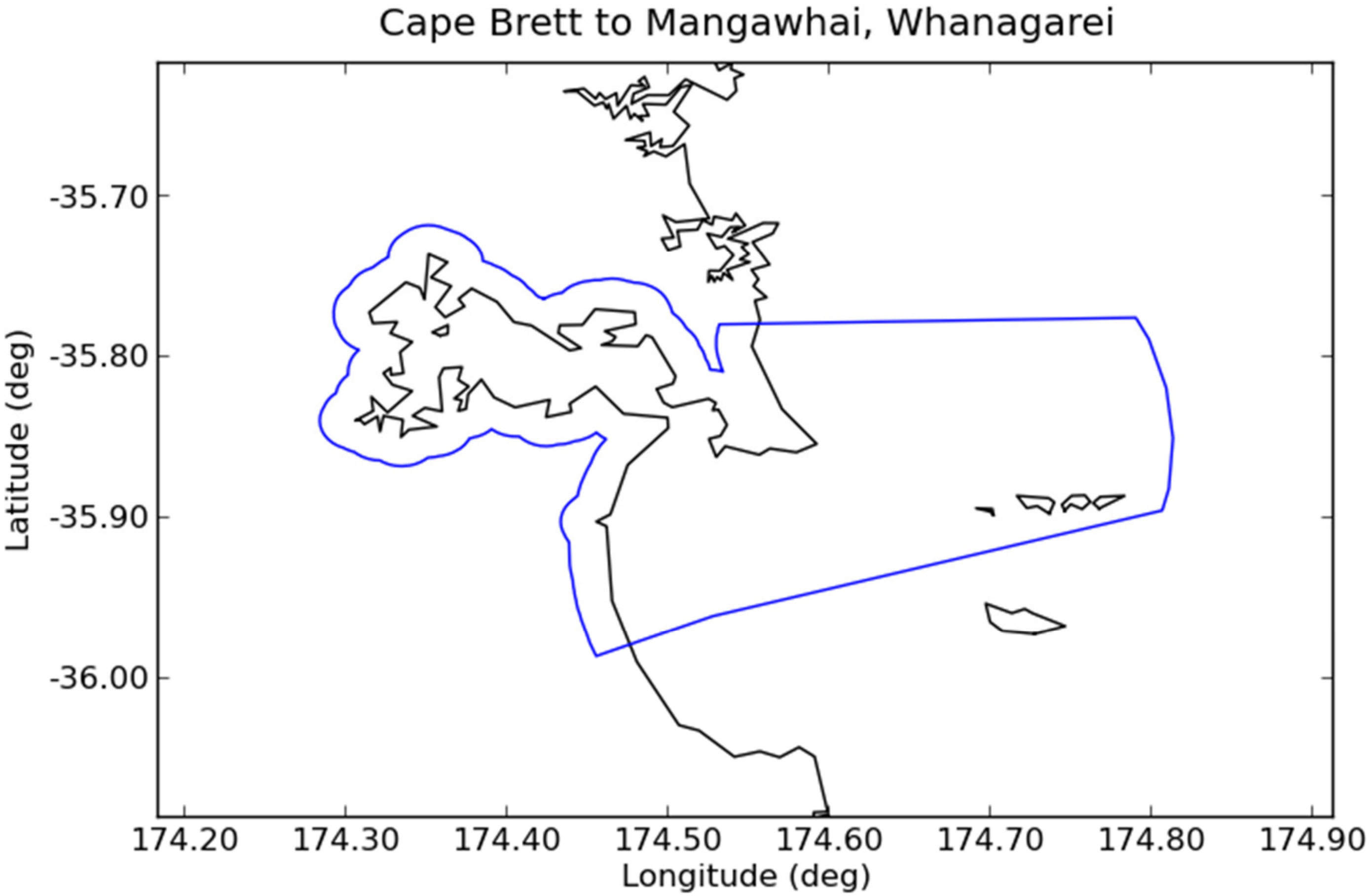


WELLINGTON Hazard Curve, zone #91
84 percentile
50 percentile
16 percentile
Maximum Amplitude (m)
Return period (Years)
11
10
9
8
7
6
5
4
3
2
0
500
1000
1500
2000
2500

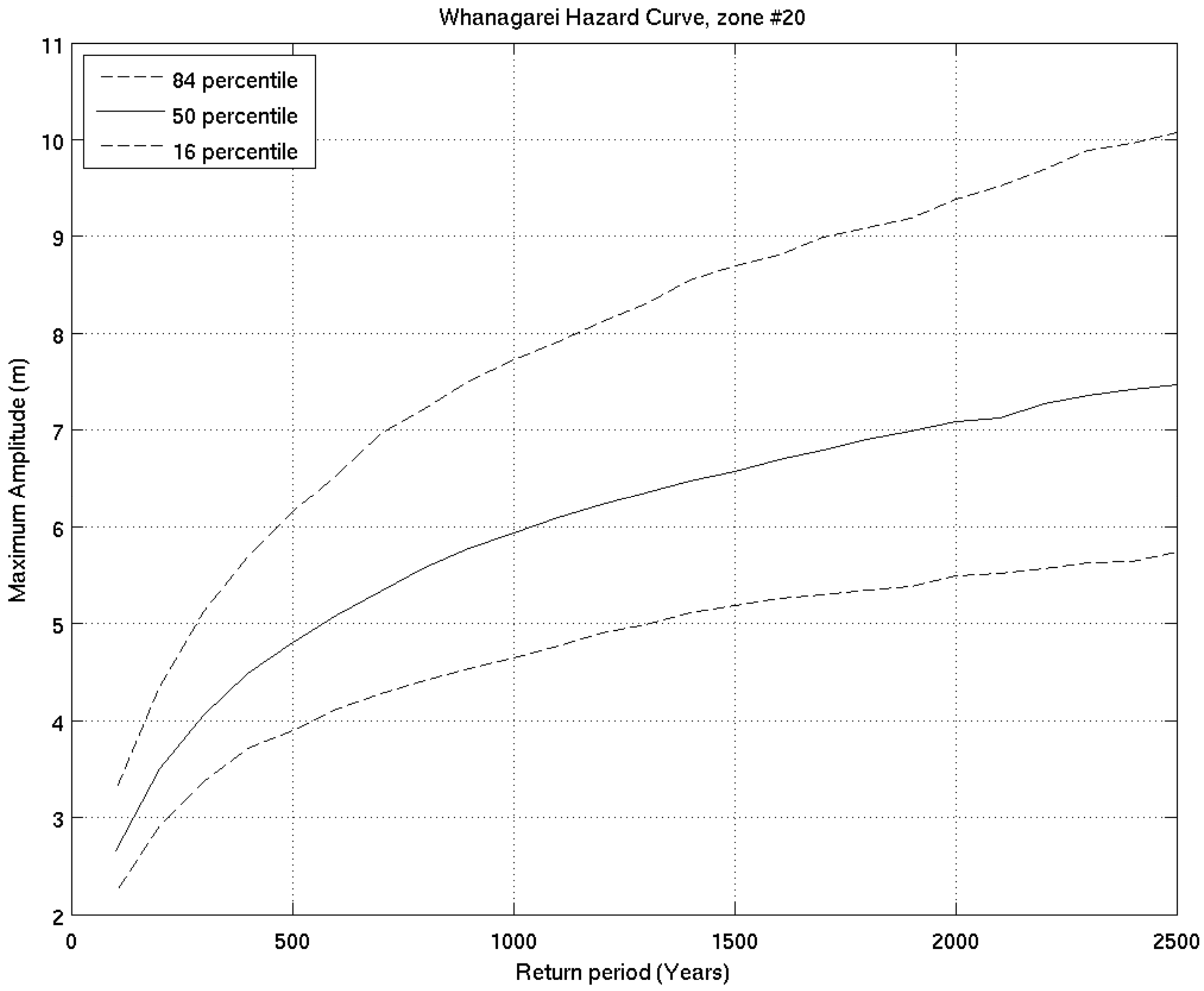

Deaggregation of Zone:91, Return Period:500 years, Tsunami Height (Maximum Amplitude) at 50th percentile:6.2373 m
NZ_WairarapNich_345:8.19
Others
NZ_PalliserKai_372:7.99
PE_Peru:9.45
NZ_Hikur:8.675
NZ_Mascarin_317:7.99
NZ_JorKekNeed_374:8.19

Deaggregation of Zone:91, Return Period:2500 years, Tsunami Height (Maximum Amplitude) at 50th percentile:9.1201 m

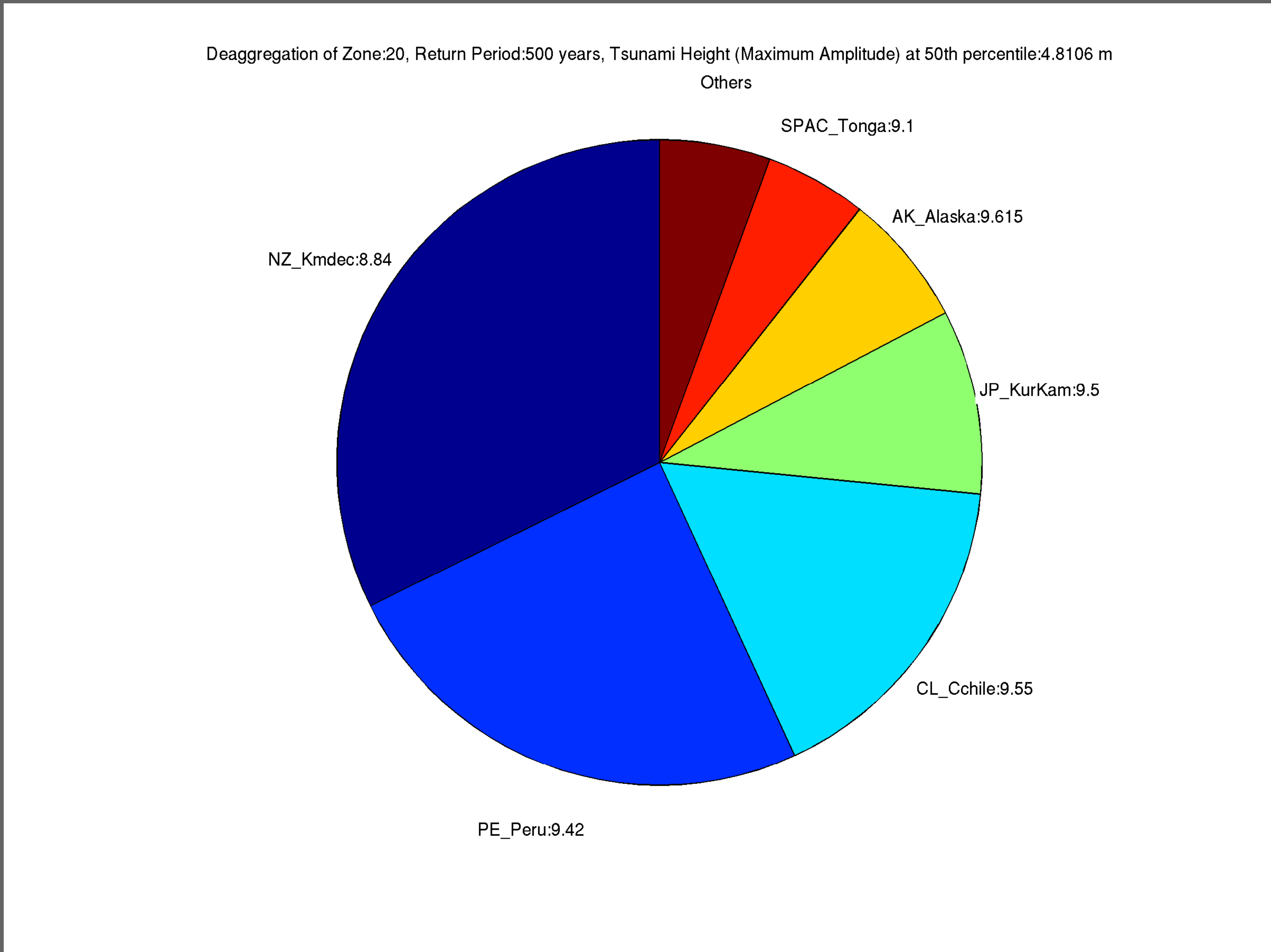




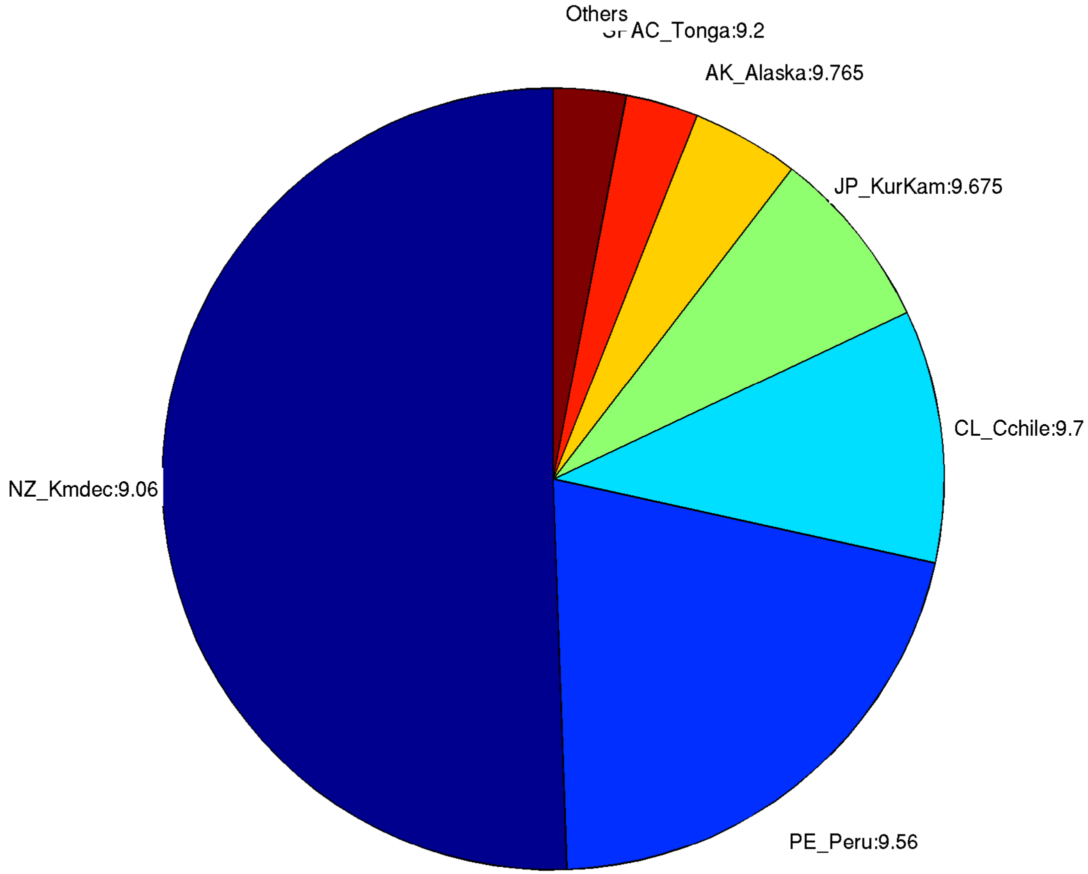
Cape Brett to Mangawhai, Whanagarei
-35.70
-35.80
-35.90
-36.00
Latitude (deg)
174.20
174.30
174.40
174.50
174.60
174.70
174.80
174.90
Longitude (deg)



Whanagarei Hazard Curve, zone #20
84 percentile
50 percentile
16 percentile
Maximum Amplitude (m)
Return period (Years)
11
10
9
8
7
6
5
4
3
2
0
500
1000
1500
2000
2500


Deaggregation of Zone:20, Return Period:500 years, Tsunami Height (Maximum Amplitude) at 50th percentile:4.8106 m
Others
SPAC_Tonga:9.1
AK_Alaska:9.615
NZ_Kmdec:8.84
JP_KurKam:9.5
CL_Cchile:9.55
PE_Peru:9.42

Deaggregation of Zone:20, Return Period:2500 years, Tsunami Height (Maximum Amplitude) at 50th percentile:7.4531 m



# Key conclusions

- Tectonic plate boundaries close to New Zealand may experience larger earthquakes than was recognised in 2005.
- Consequently the threat from tsunamis caused by earthquakes close to New Zealand is greater than was thought in 2005.
- The biggest increases in estimated hazard are typically in those parts of the country that face towards the subduction plate interfaces. i.e. east facing coasts of the North Island, and the southwest of the South Island.

## Implications of the report

- Preparedness for local tsunami is important…
- Know the natural warnings of tsunami, and self-evacuate if you observe them…
- Don’t wait for sirens…
- Consistent standards for sirens…
- Evacuation zones may need to be updated in some areas…

# Propose new Level 3, if validation succesful

- Level 1Is a simple ‘bathtub’ model in which inundation is determined based on a maximum wave height (Fig. 1), projected inland from the coast to some cut-off elevation. This approach provides the crudest and simplest method of mapping evacuation zones.

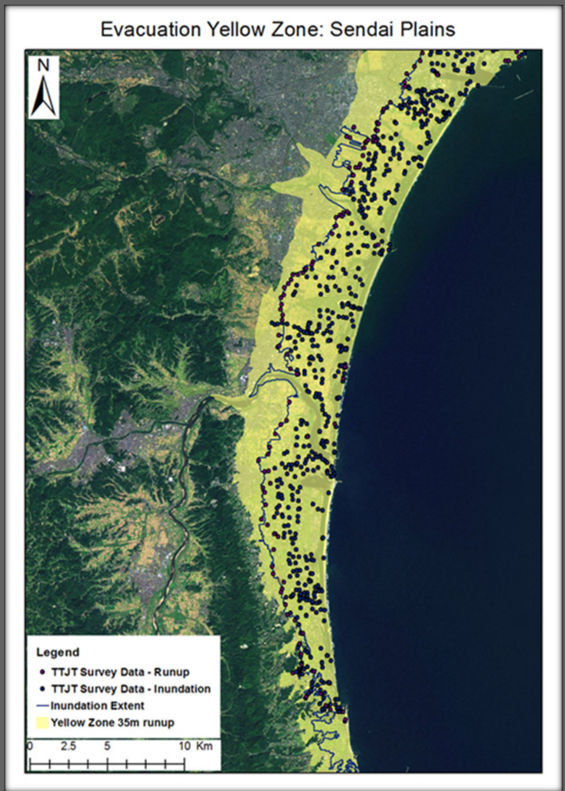
- Level 2 Uses a measure of rule-based wave height attenuation inland from the coast. GIS can be utilised for applying the attenuation rule. This approach derives a more realistic output than a simple ‘bathtub’ model but is still a rough estimation which cannot account for physical variations in wave behaviour. This rule does not account for all scenarios and improvements are expected to come with time. Local knowledge must also be applied to support the process.

- Level 3 Is a computer-derived simulation model that theoretically allows for complexities that a simpler ‘rule’ cannot, such as varied surface roughness from different land uses, and water turning corners and travelling laterally to the coast on its inundation path. Such modelling is expensive and the quality of outputs is dependent on the science behind the hazard model.

- Level 4 Is the most complete modelling, based on an envelope around all inundations from multiple well-tested computer models. Development to this level of sophistication will require a comprehensive scientific understanding of all possible tsunami sources (distant, regional and local), wave propagation and inundation behaviours, across a range of magnitudes.

# Validation exercise

- **GNS intends to perform a validation to see how well evacuation zones defined by inundation modelling based on deaggregated scenarios would have worked in Japan 2011**



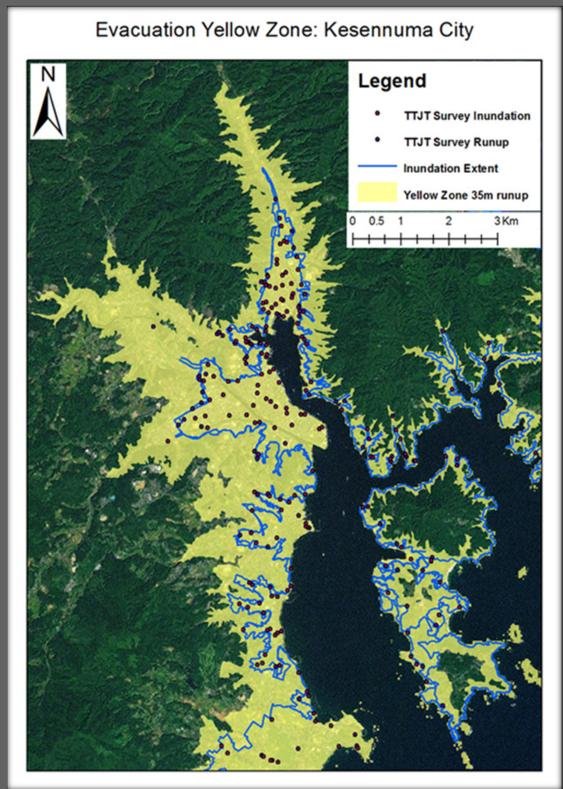




Figure shows comparison of Level 2 Evacuation zone with observations