Earthquake scenario selection for tsunami inundation hazard assessment

Scenario-based approach

Australian Government
Geoscience Australia

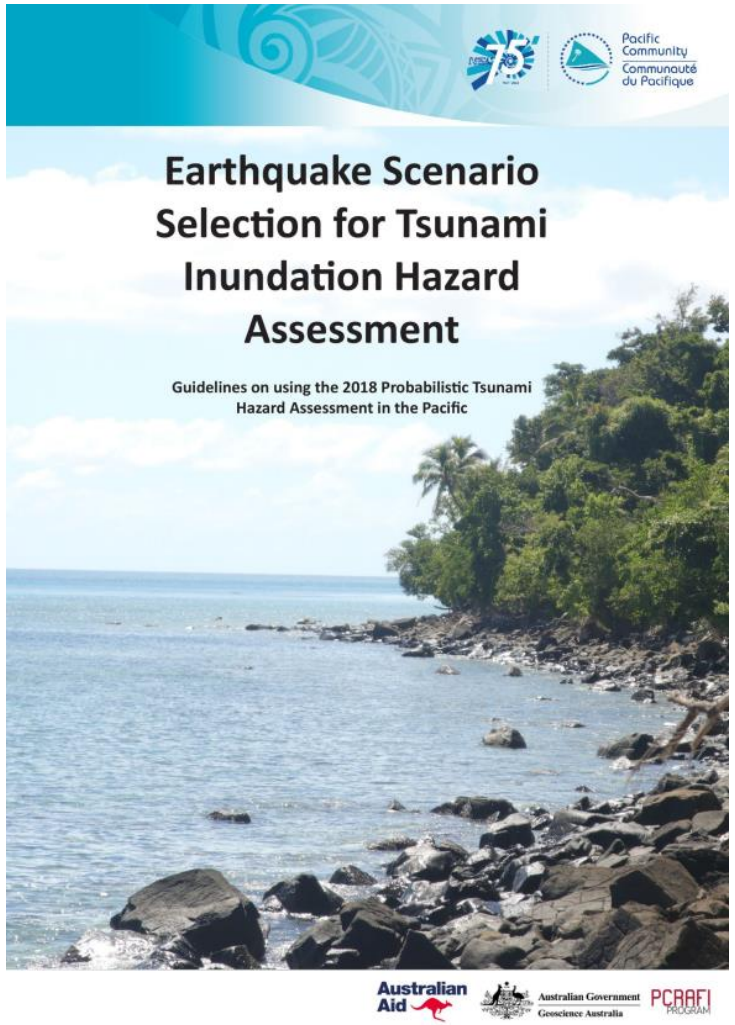
PCRAFI
Pacific Catastrophe Risk Assessment & Financing Initiative

Australian Aid

WORLD BANK GROUP

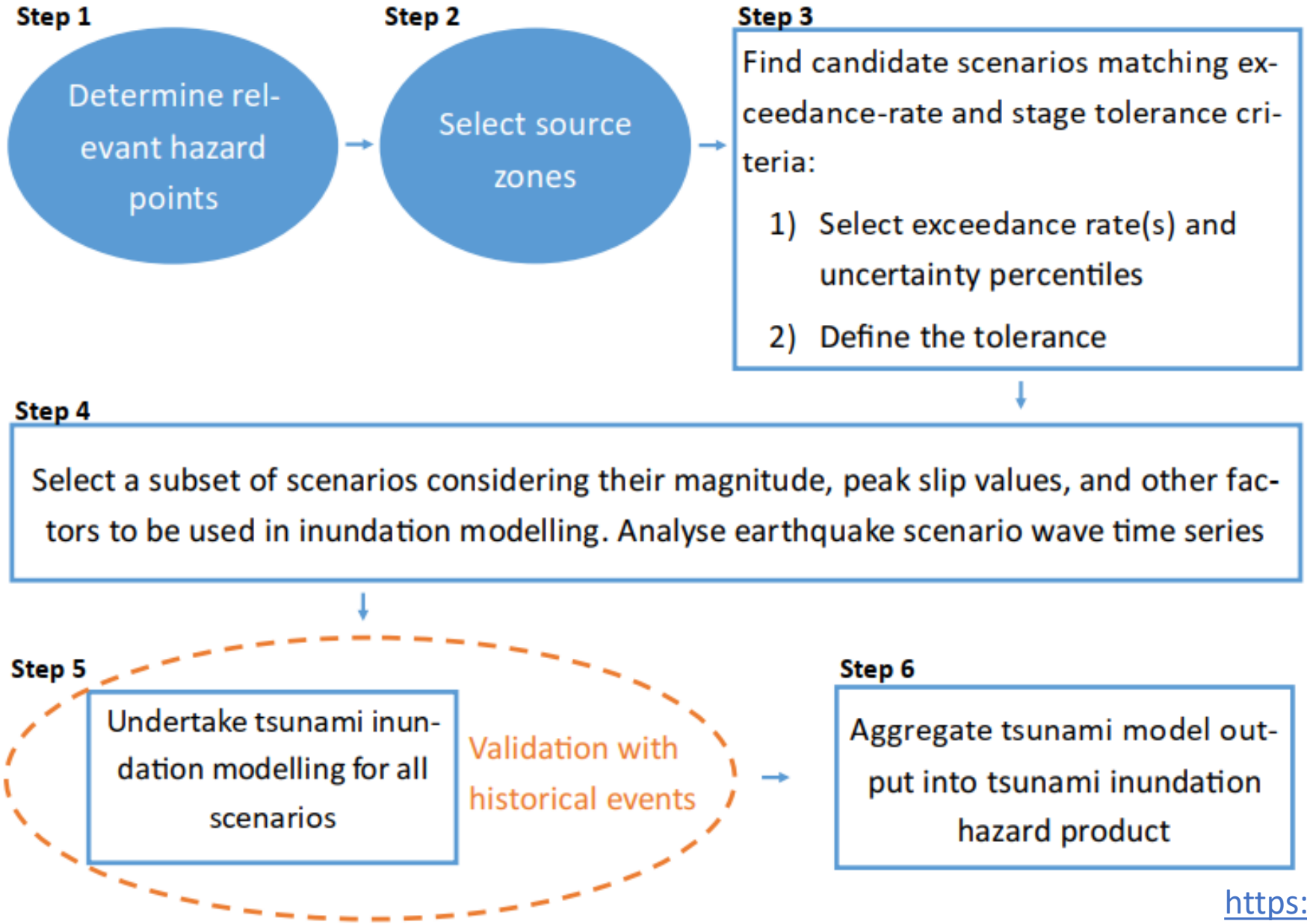
Scenario based approach

- Simulation of limited number of tsunami scenarios with nominal return periods, inferred from the offshore PTHA locations
- Easier to implement
- Greater control over which scenarios are selected for modelling
- Decisions involve expert judgement
- Highly recommend consultation with key end-users
- Less computationally demanding
- Practical approach when we cannot simulate large number of events



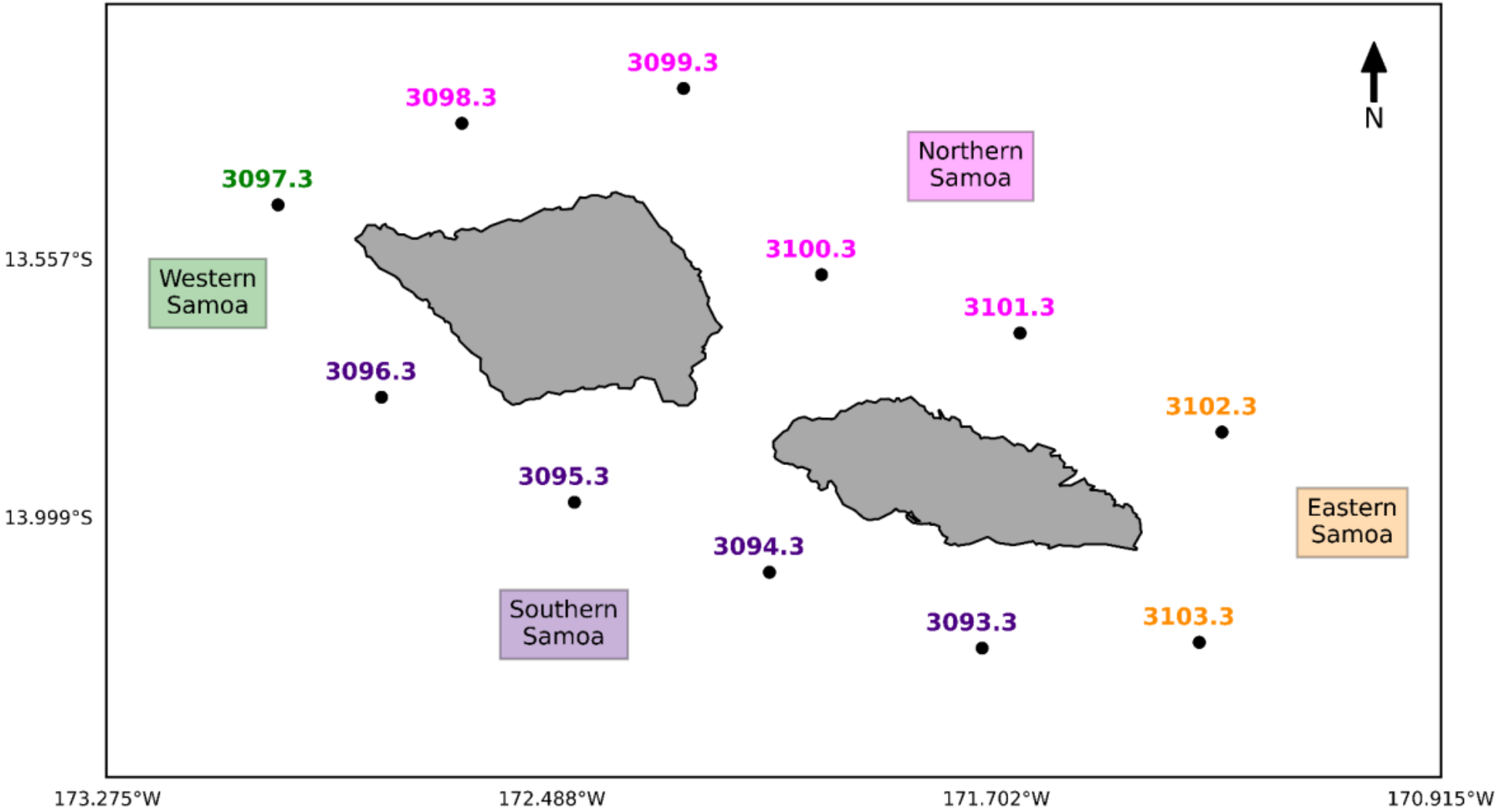
https://purl.org/spc/digilib/doc/dmup7

Scenario-based approach

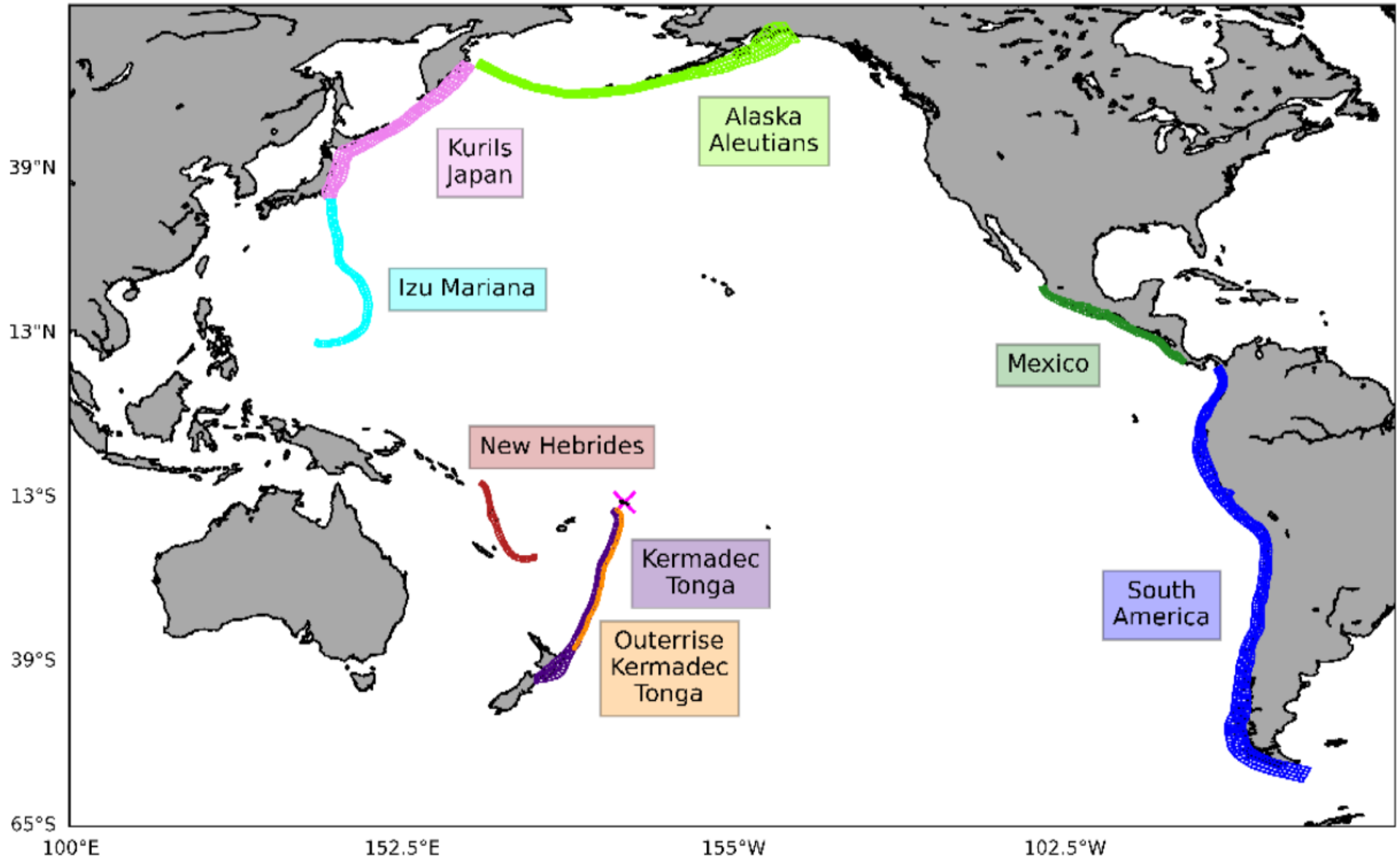


https://bit.ly/38Wm5gv

Step 1: Hazard/Offshore point selection



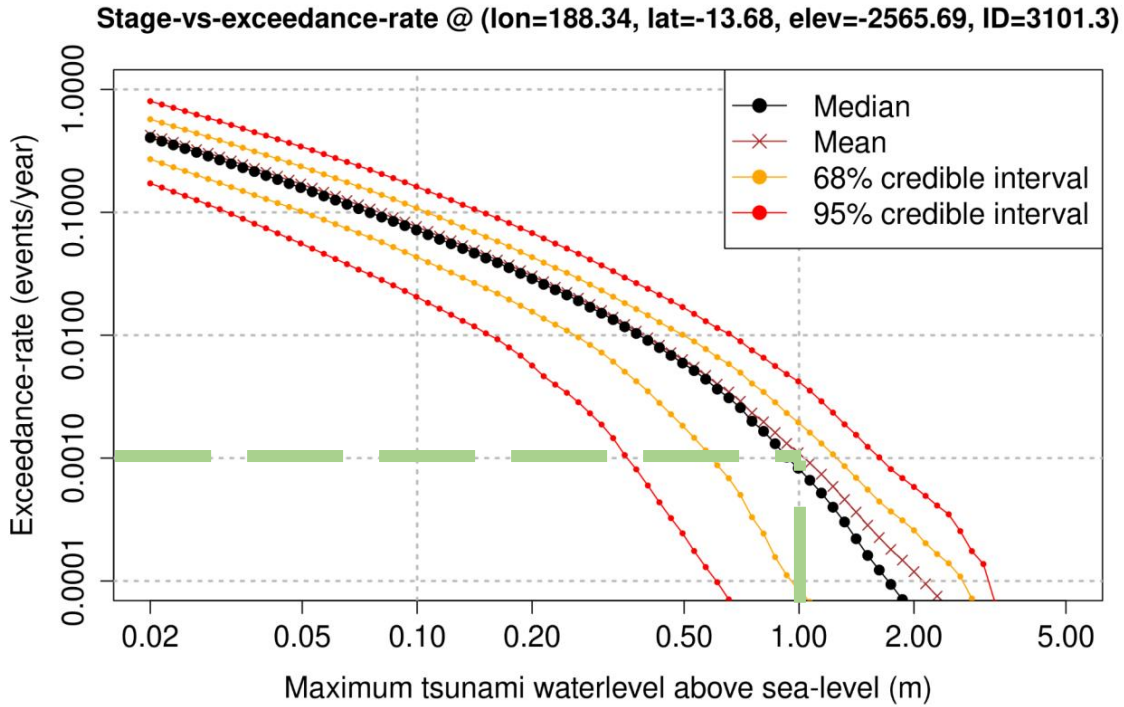
Step 2: Source zone selection and earthquake slip type



Step 3: Candidate scenario selection

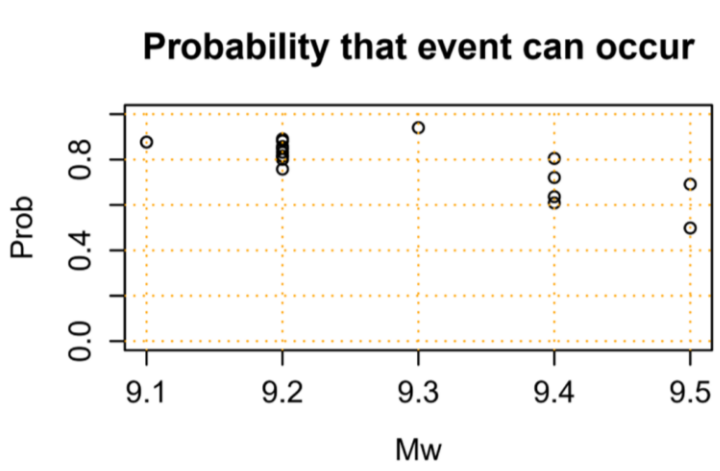
- Matching the exceedance rate and stage tolerance criteria

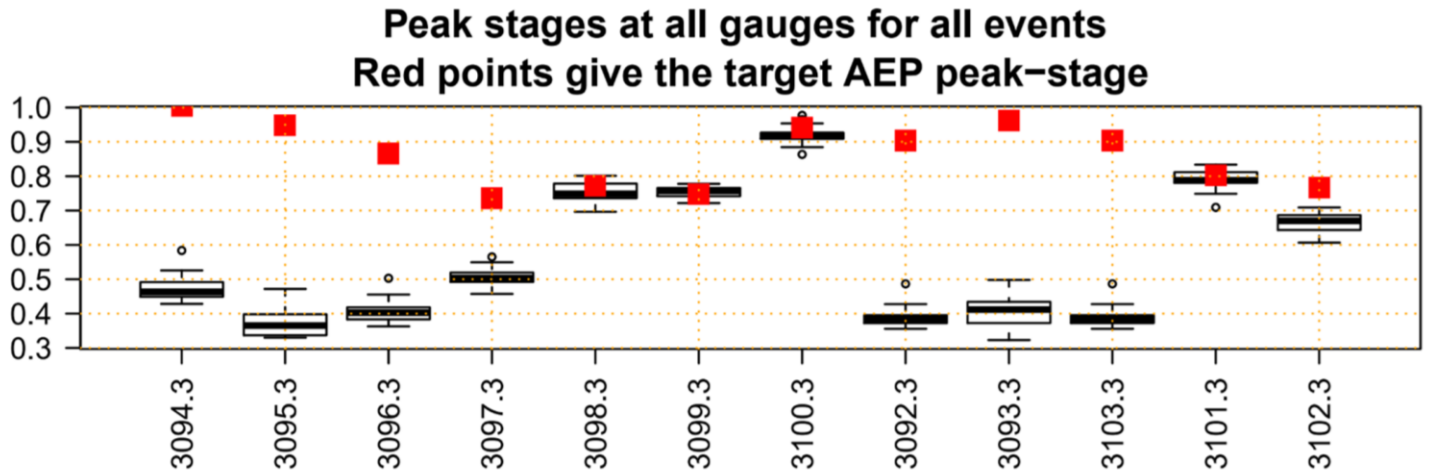
Exceedance Rate (events/yr)	Average Recurrence Interval (yr)
0.01	100
0.002	500
0.001	1000
0.0004 (84th percentile)	2500 (84th percentile)

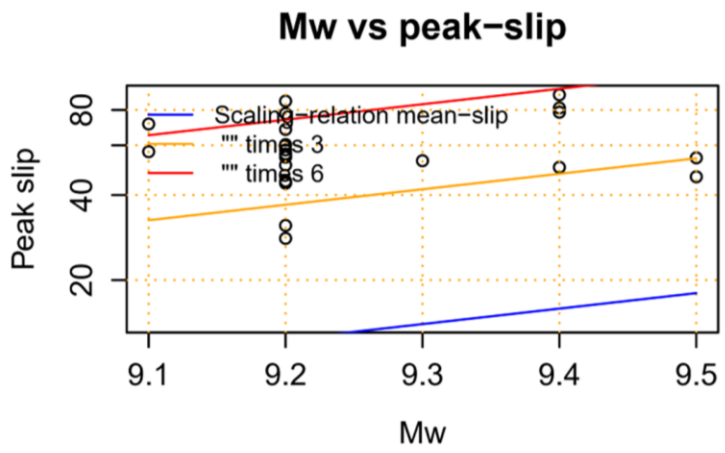


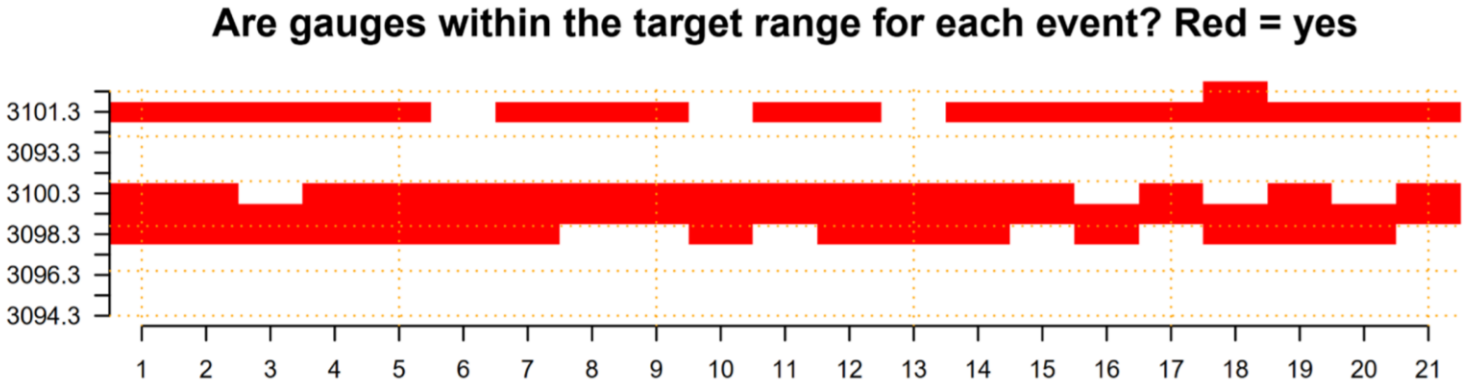
Step 4: Final scenario selection

ALASKA ALEUTIAN 500 YEAR



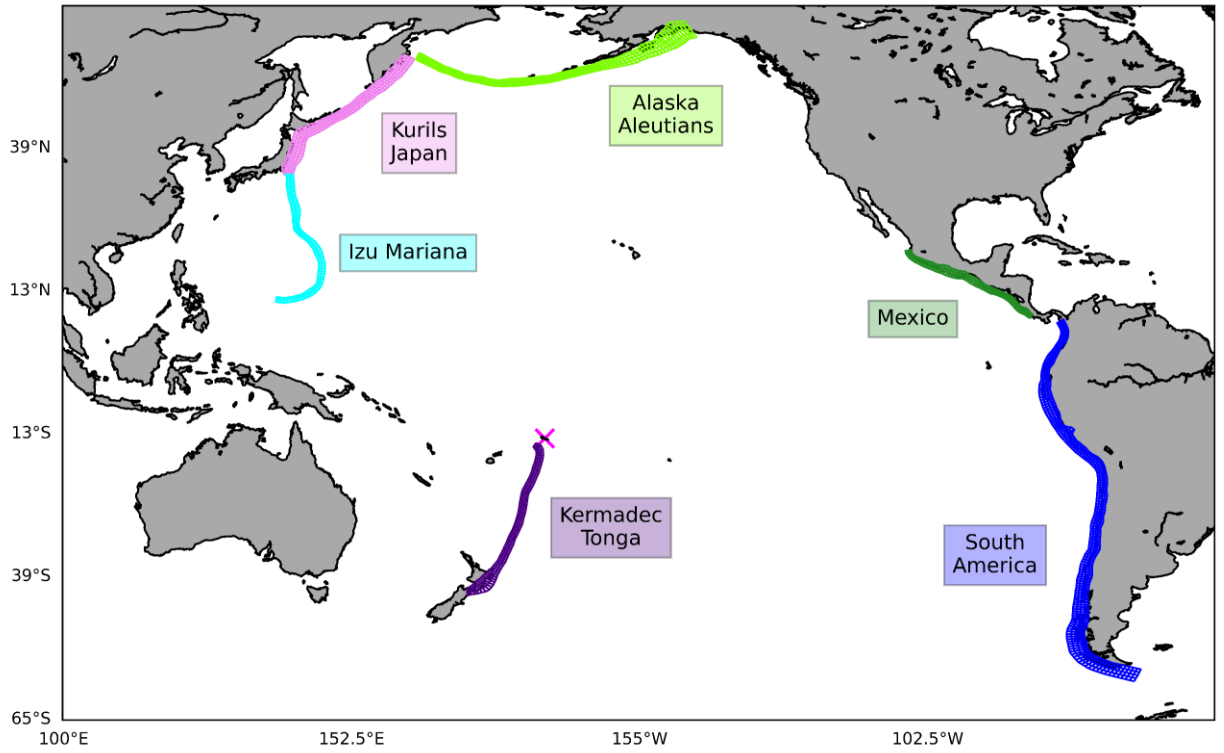






Samoa Case Study

- Total of 68 scenarios selected
  - 6 sources
  - 4 return periods



SOURCES	RP 100	RP 500	RP 1000	RP 2500	Total (per source)
Alaska Aleutians	3	3	2	3	11
Izu Mariana	2	1	0	0	3
Kermadectonga	4	5	3	3	15
Kurils Japan	4	3	3	0	10
Mexico	2	1	0	0	3
South America	6	5	6	9	26
TOTAL (per rp)	21	18	14	15	68

Step 5: Tsunami inundation modelling

- For Samoa case study, the tsunami was simulated using the PTHA18 deformation grids to define the earthquake-induced ocean surface perturbation for each scenario
- BG-Flood Model
  - Sensitivity analysis
  - Historical event validation (Japan 2011 & Samoa 2009)

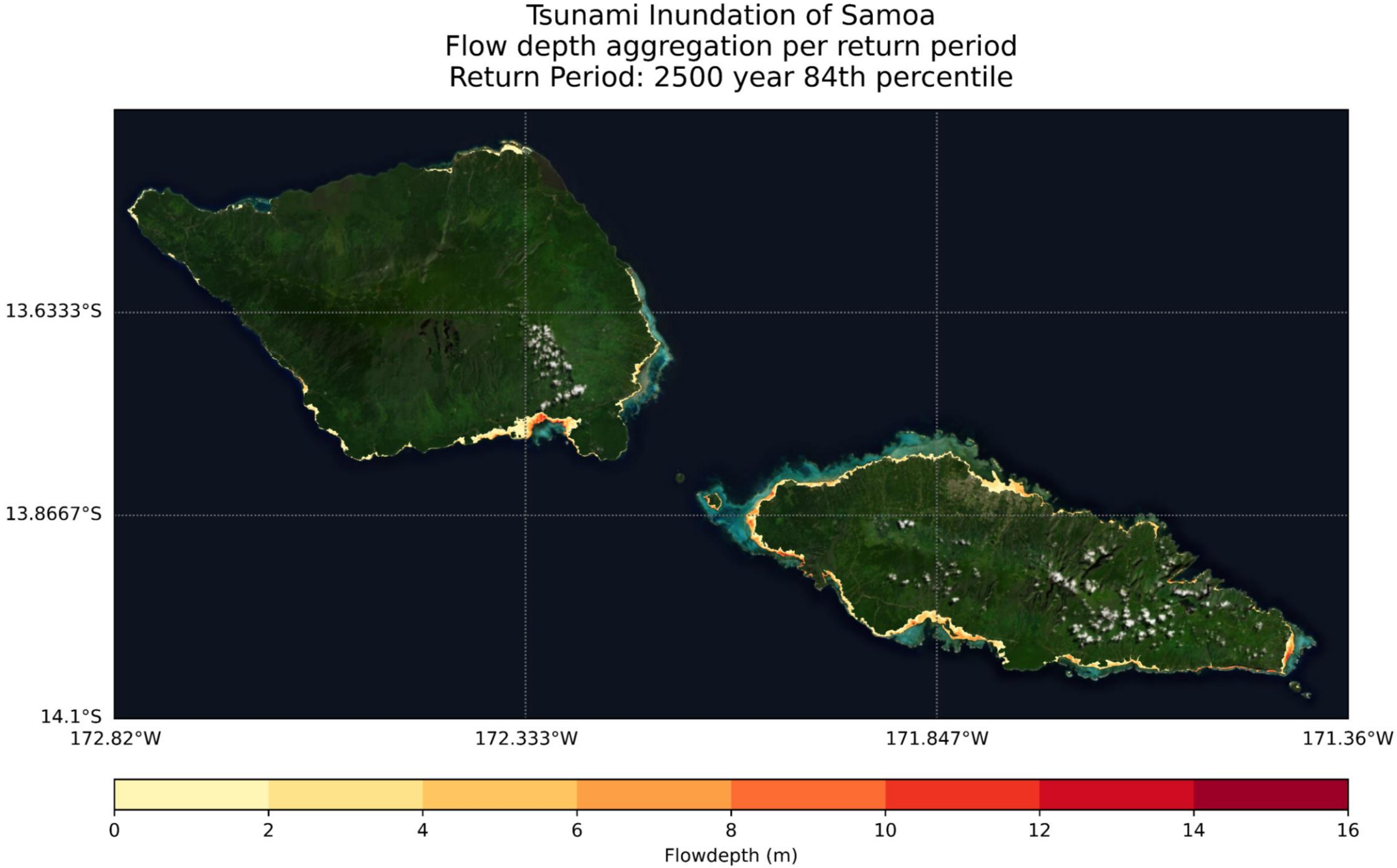
NIWA
Taihoro Nukurangi

https://github.com/CyprienBosserelle/BG_Flood

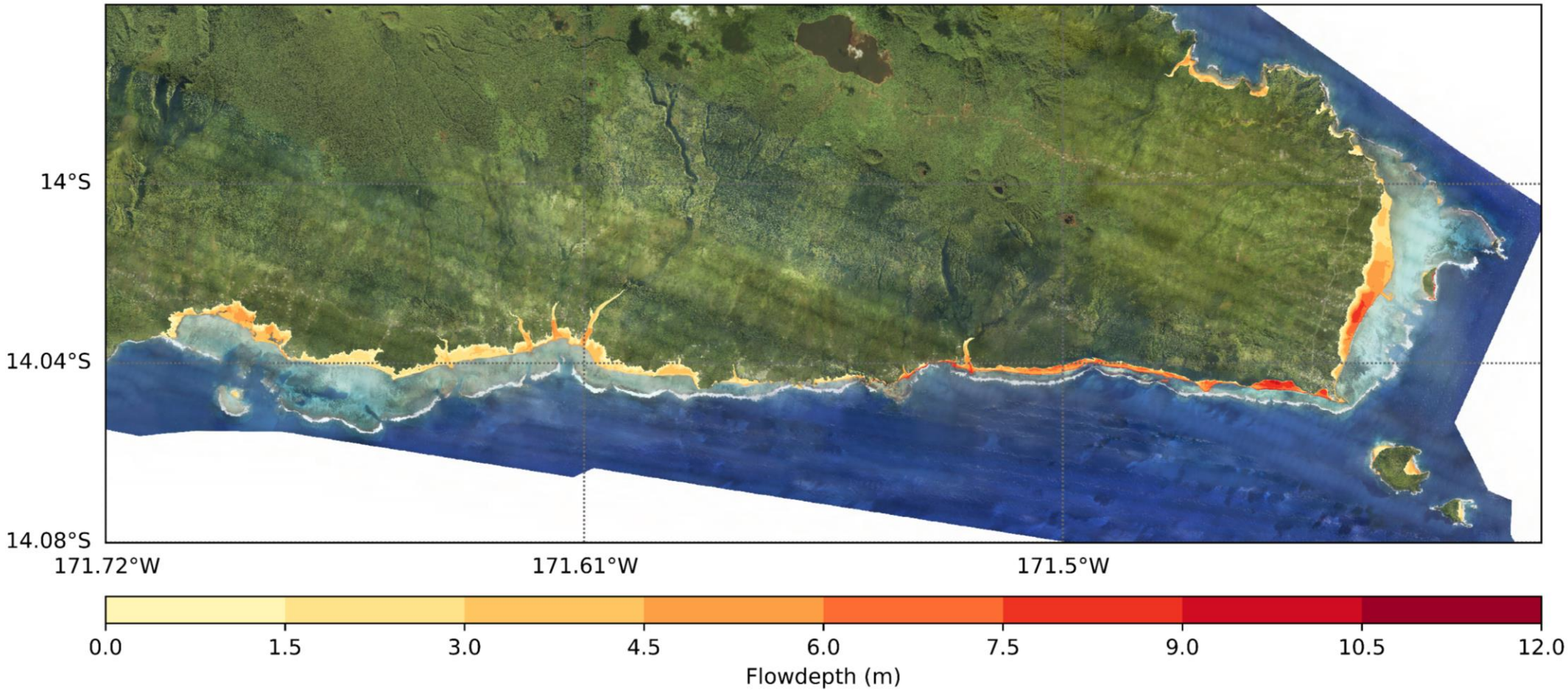
Step 6: Result Aggregation

Aggregated the Return Periods:

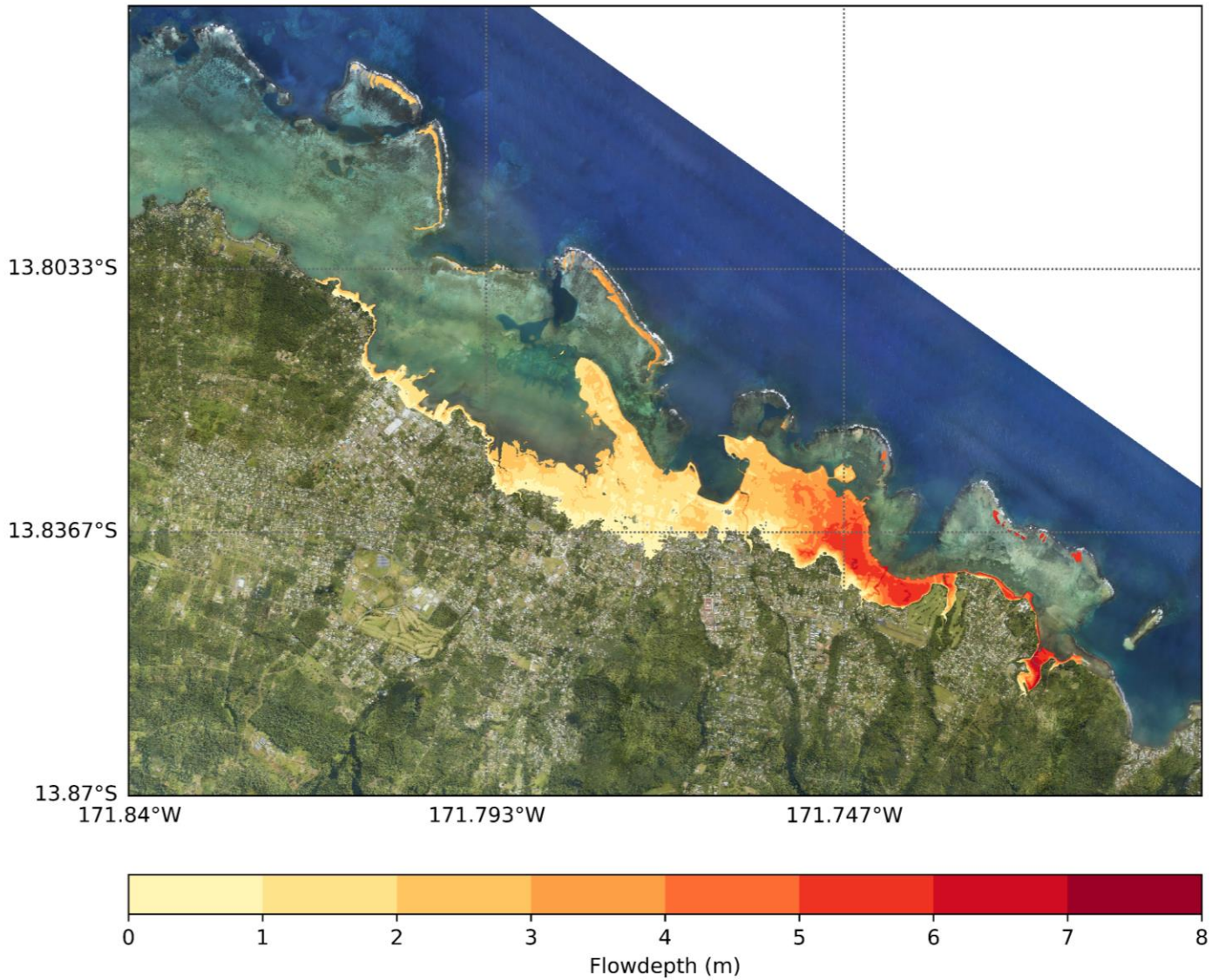
- 100 year
- 500 year
- 1000 year
- 2500 year


Tsunami Inundation of Samoa
Flow depth aggregation per return period
Return Period: 2500 year 84th percentile
13.6333°S
13.8667°S
14.1°S
172.82°W
172.333°W
171.847°W
171.36°W
0
2
4
6
8
10
12
14
16
Flowdepth (m)

Tsunami Inundation of South East Upolu, Samoa
Flow depth aggregation per return period
Return Period: 2500 year 84th percentile



Tsunami Inundation of Apia, Samoa
Flow depth aggregation per return period
Return Period: 2500 year 84th percentile



Limitations

- Onshore hazard results do not formally approximate the results that would be obtained by simulating all scenarios in the offshore PTHA
- Due to the need for subjective judgement, different users are likely to obtain slightly different answers when applying the technique
- Uncertainties that are represented in the offshore PTHA are not comprehensively represented in the onshore hazard results

Summary – Scenario based approach

Pros	Cons
Is flexible	Involves subjective judgement
Can target specific events	Does not formally approximate the inundation hazard that would be obtained by simulating all offshore PTHA scenarios
User judgement can easily influence the scenario selection	Uncertainties are not rigorously represented
Number of scenarios can be kept low and reduce computational costs	