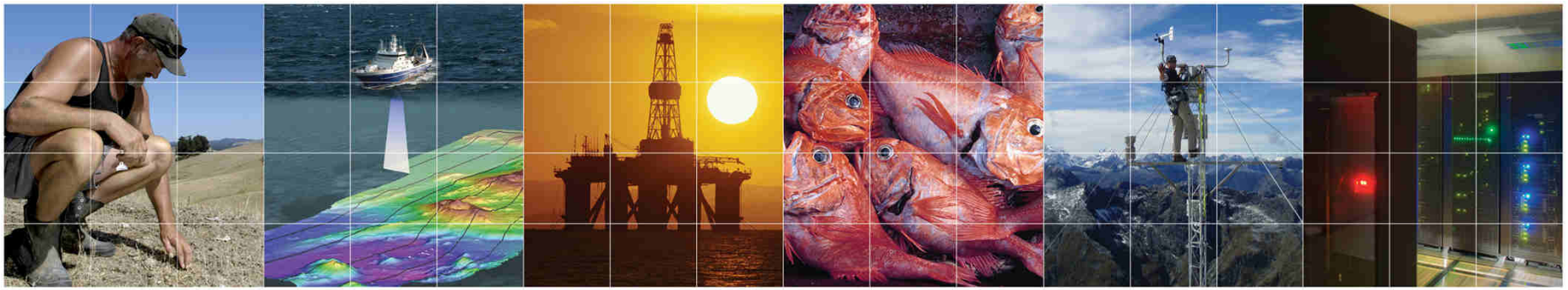
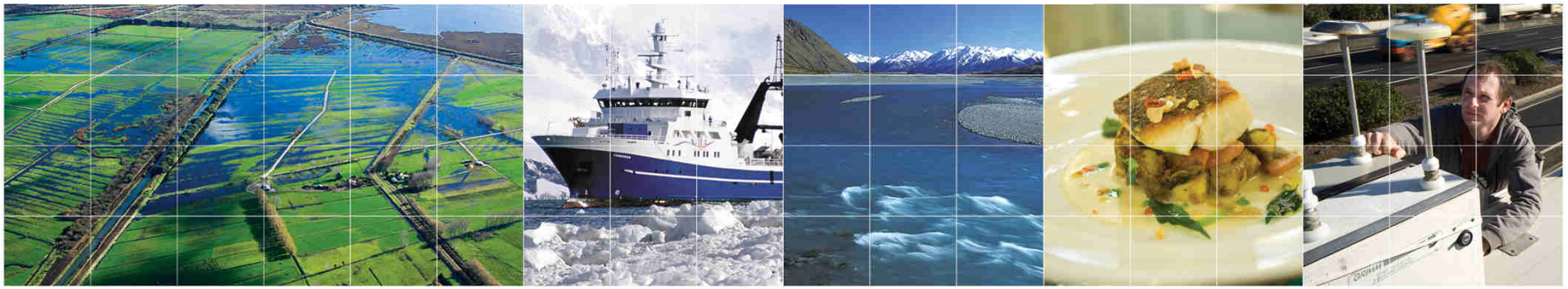


Preliminary 3,000 year-long tsunami and cyclone history for the Samoan Islands based on sedimentary records

Shaun Williams

National Institute of Water and Atmospheric Research Limited, Christchurch, NZ.

This work was carried out from 2010-2014 when the presenter was undertaking PhD Research at the University of Canterbury NZ, Geological Sciences Department, Christchurch.

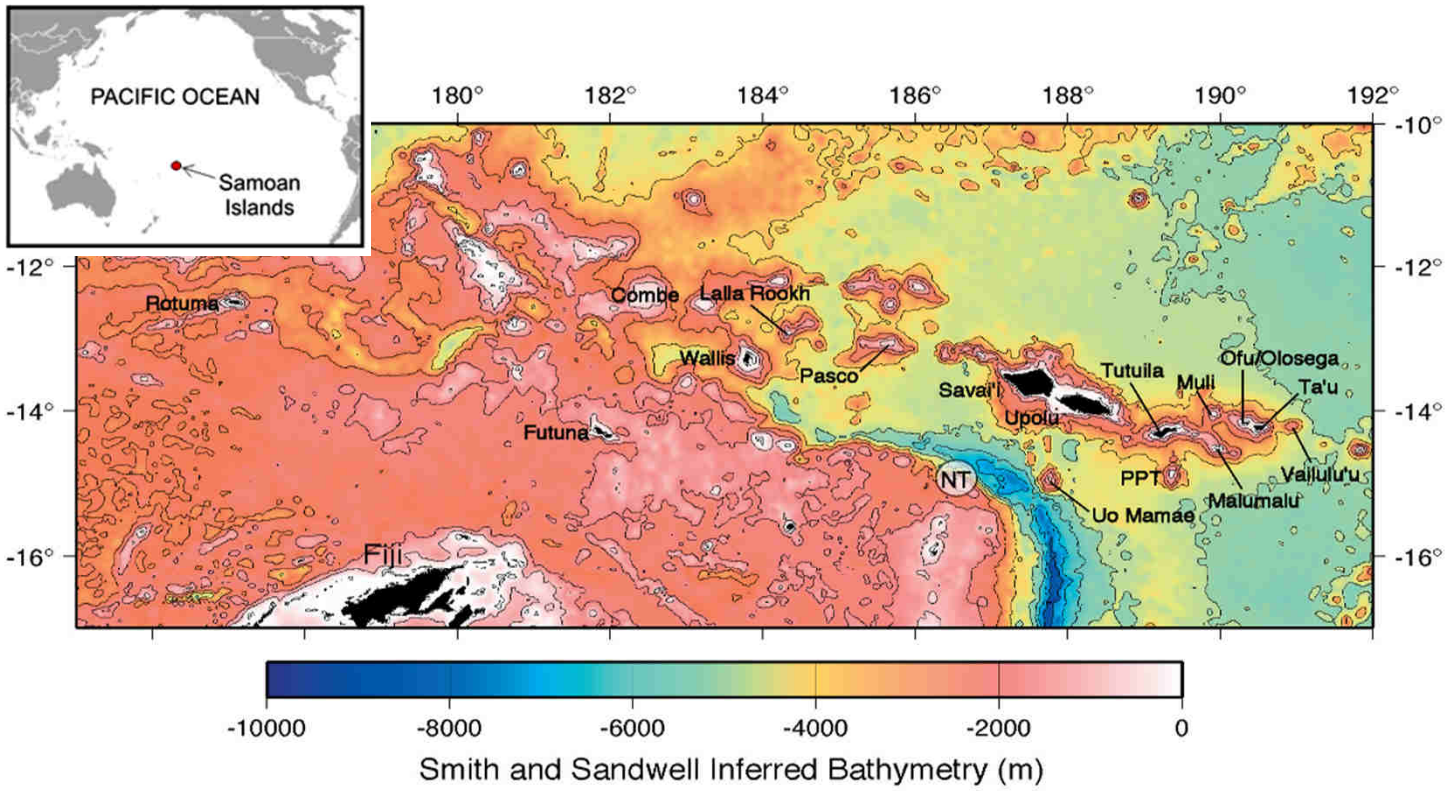


Follow up & Acknowledgement of:

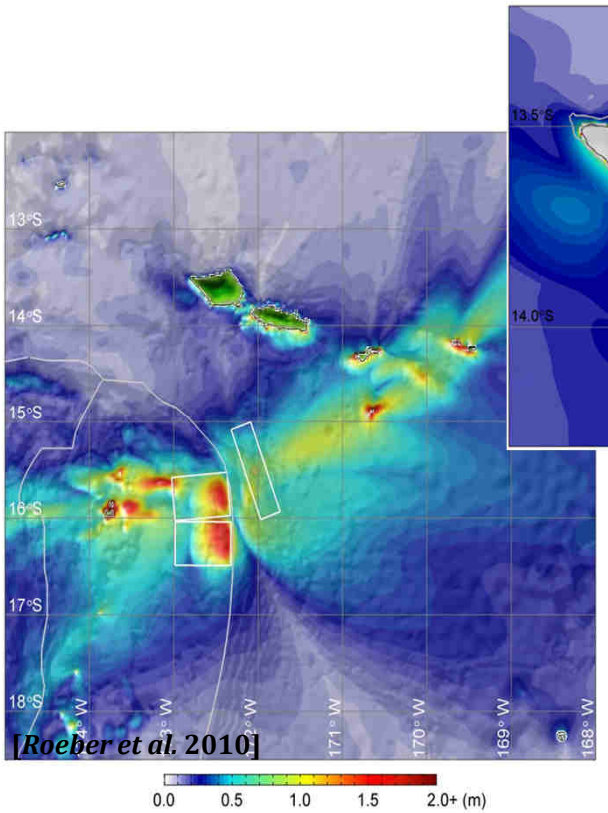
Talk Outline

- Background
- Tsunami & Cyclone deposits/chronology
- Applications
- *End*

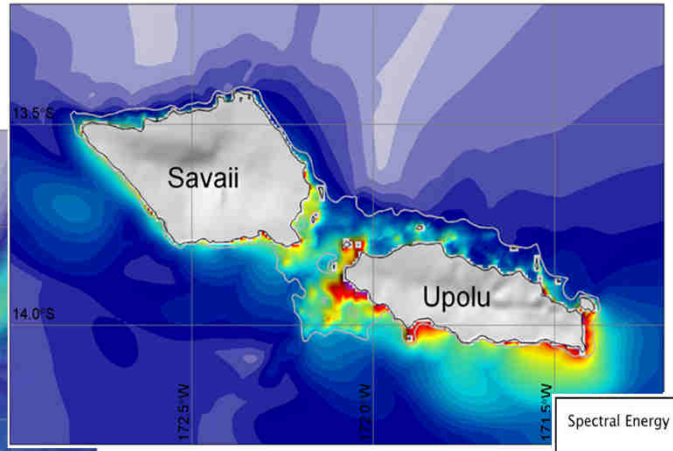
Background


PACIFIC OCEAN
Samoan Islands
180°
182°
184°
186°
188°
190°
192°
-10°
-12°
-14°
-16°
Rotuma
Combe
Lalla Rookh
Wallis
Pasco
Futuna
Fiji
Savai'i
Upolu
Tutuila
Muli
Ofu/Olosega
Ta'u
NT
PPT
Uo Mamae
Malumalu
Vailulu'u
-10000
-8000
-6000
-4000
-2000
0
Smith and Sandwell Inferred Bathymetry (m)

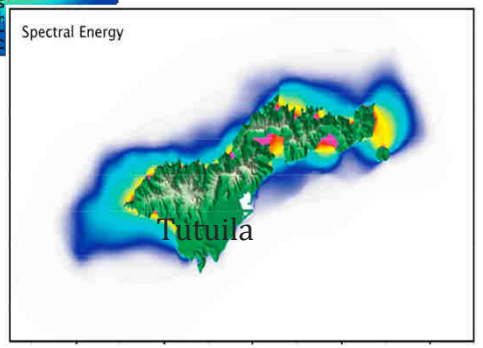
Background



[*Roeber et al.* 2010]



2009 Tsunami



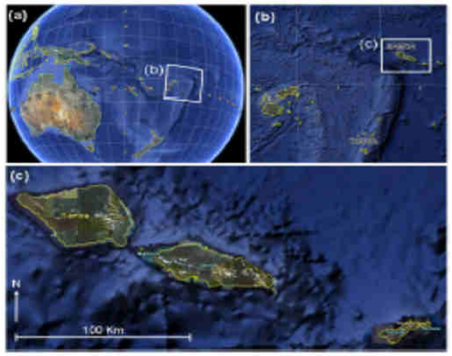
Background

United Nations Educational, Scientific and Cultural Organization

Australian Tsunami Research Centre
School of Biological, Earth and Environmental Sciences

UNESCO-IOC International Tsunami Survey Team Samoa (ITST Samoa)

Interim Report of Field Survey
14th – 21st October 2009



(Source: Google Earth, 2009)

Report presented to the Government of Samoa
Monday 26th October 2009

RECOMMENDATION 1: "Retain and *enhance* community-based tsunami education activities" – these saved lives on 29th September 2009

RECOMMENDATION 4: Complete a national palaeotsunami study to identify long-term frequency-magnitudes of tsunamis

UNSW

RECOMMENDATION 2: Collection and compilation of a detailed near shore bathymetric and coastal topographic datasets to help with future tsunami modelling for risk assessment

RECOMMENDATION 3: New buildings should be built on raised 'platform's approximately 1 metre higher than the surrounding landscape and on solid foundations with reinforced concrete columns

RECOMMENDATION 4: Complete a national palaeotsunami study to identify long-term frequency-magnitudes of tsunamis

RECOMMENDATION 5: Replant damaged coastal areas and protect pristine coastal areas (in partnership with local communities in order to raise understanding) with species shown to increase resilience to tsunami (and extreme wave) inundation

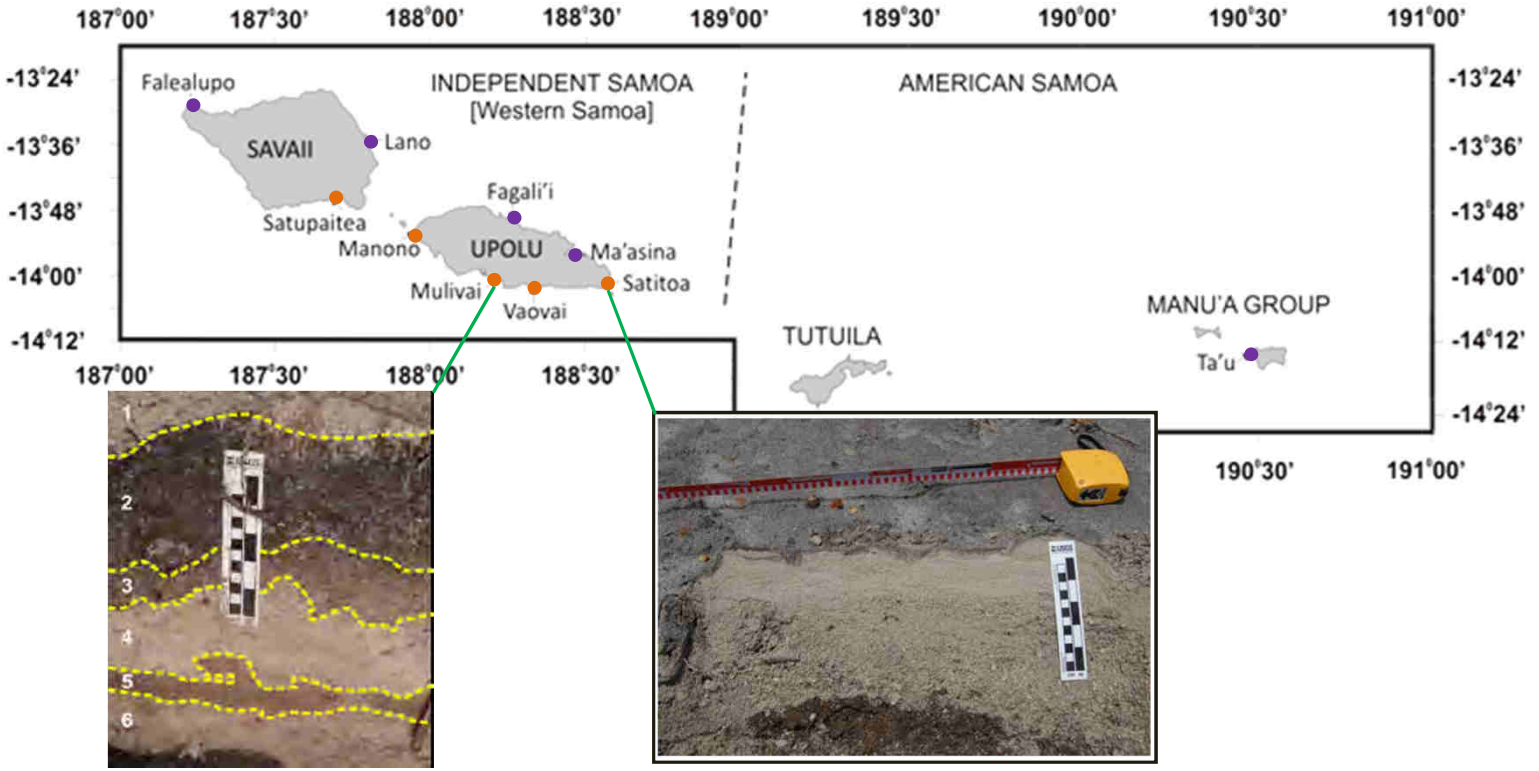
RECOMMENDATION 6: Train Samoan experts to continue to collect survivor stories. This helps with the healing process and provides valuable material to help with future awareness raising activities

Deposits study

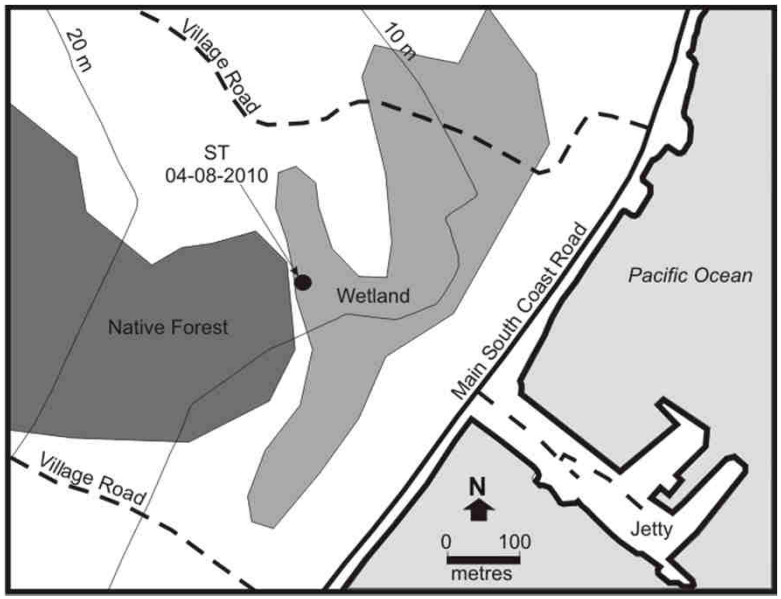
Platform for this research & objectives:

- Investigate 2009 tsunami deposits
- Establish tsunami chronology
- Improve understanding of tsunami frequency/magnitude

Deposits study

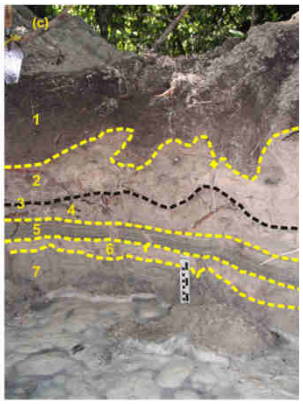


Deposits study

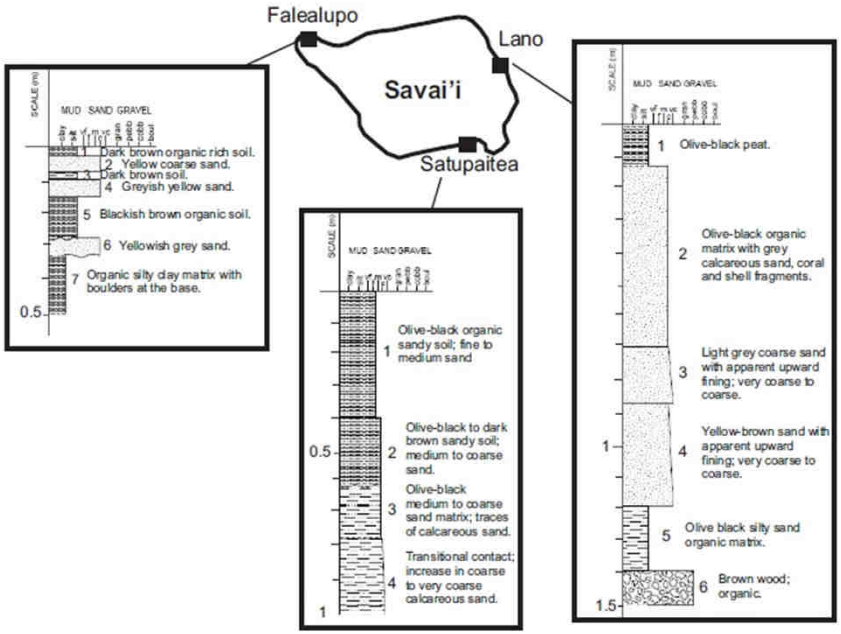


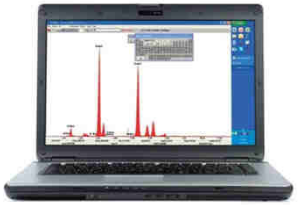
Wetland core sites

Coastal trenches where possible



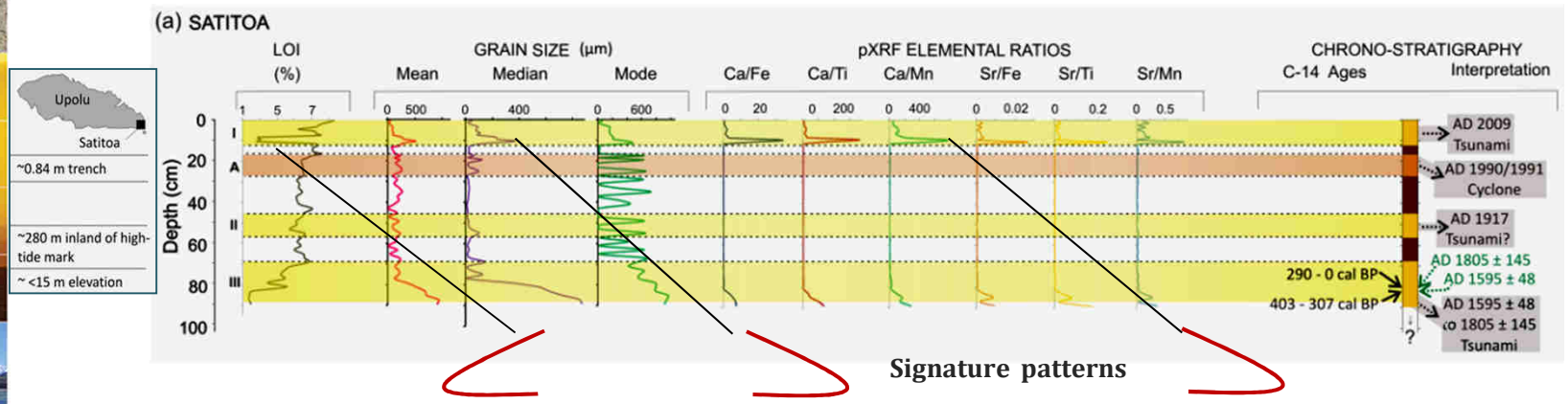
Deposits study





Deposits study

CHARACTERISING MODERN TSUNAMI & CYCLONE DEPOSITS

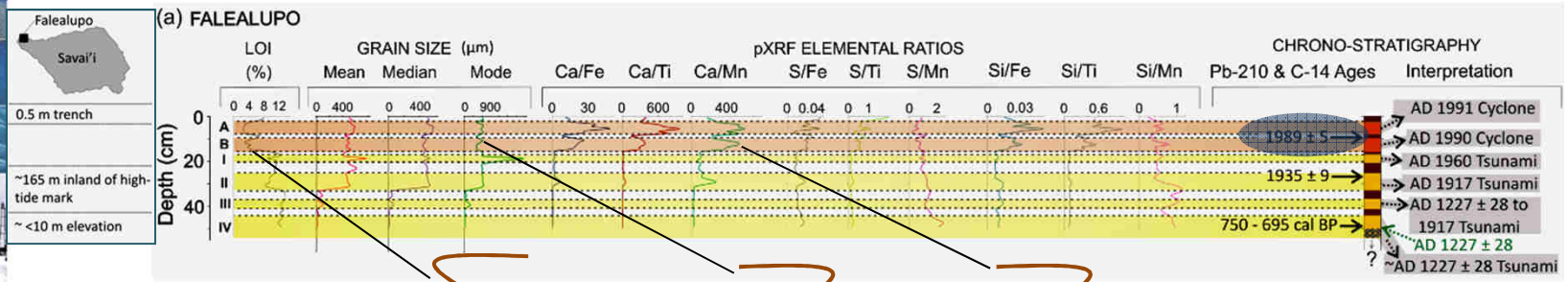


~0.84 m trench

~280 m inland of high-tide mark

~ <15 m elevation

Signature patterns



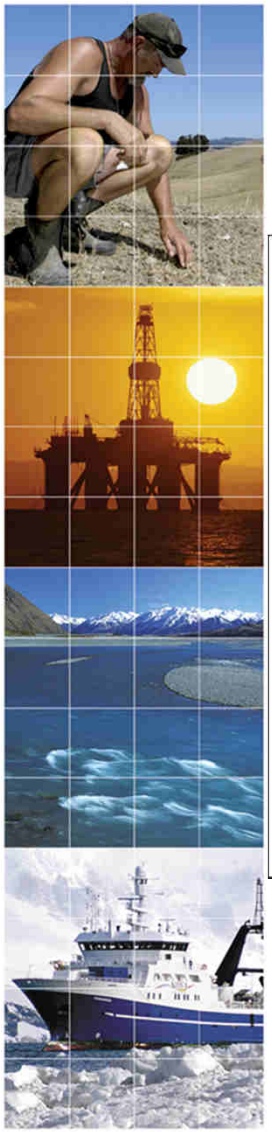
0.5 m trench

~165 m inland of high-tide mark

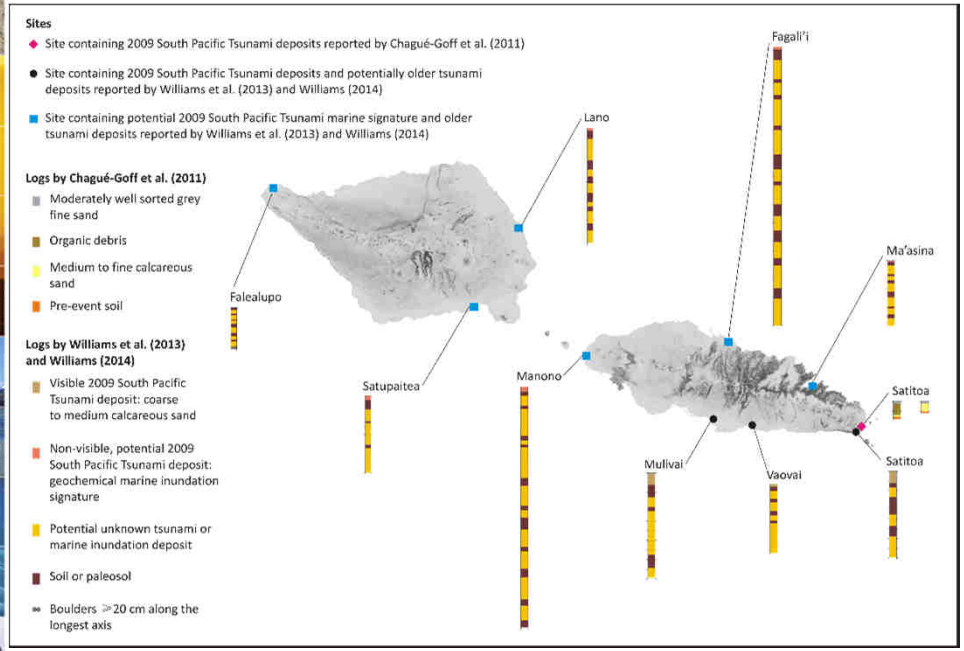
~ <10 m elevation

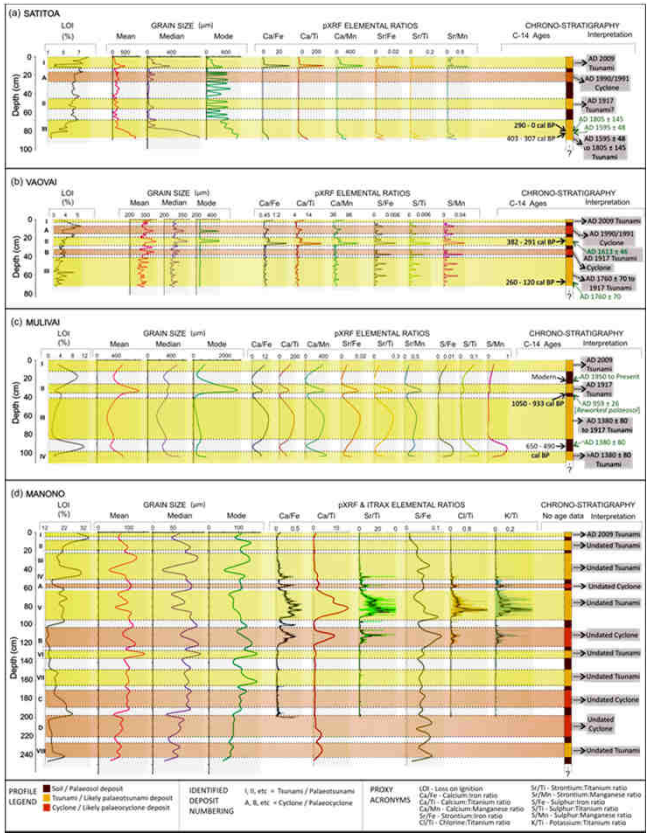
enhancing the benefits of New Zealand's natural resources

NIWA
Taihoro Nukurangi



Deposits study

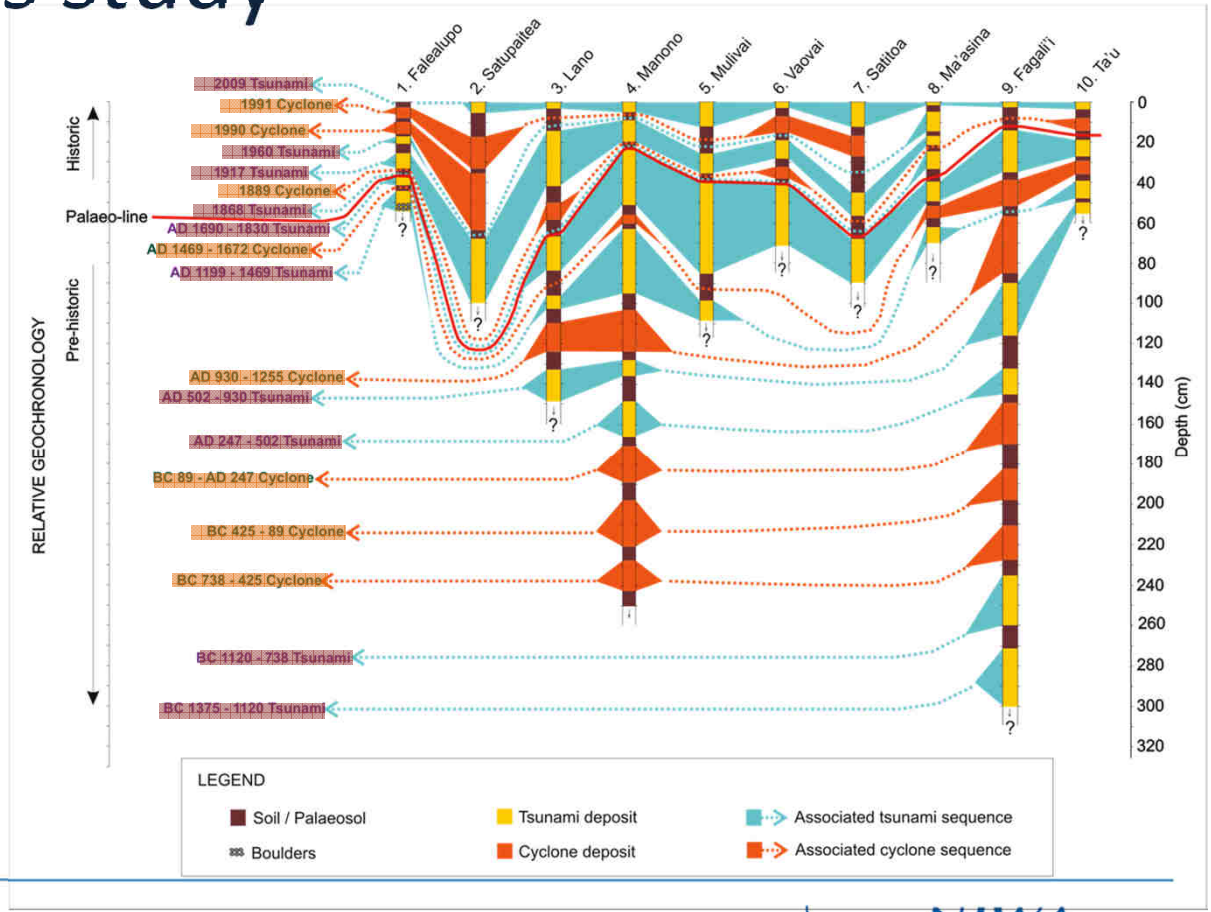


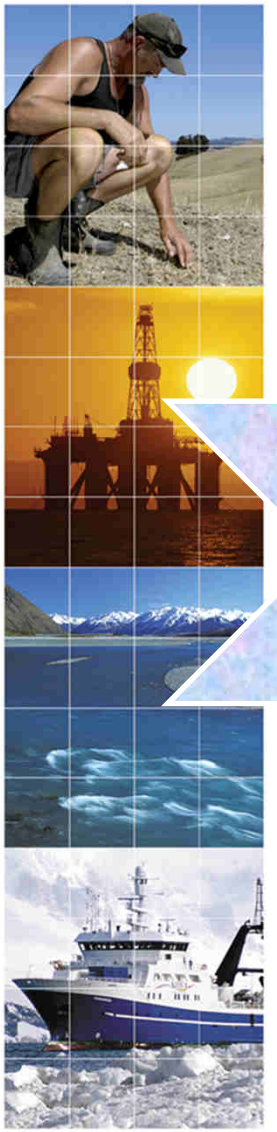


Deposits study

~3,000 year-long baseline chronology

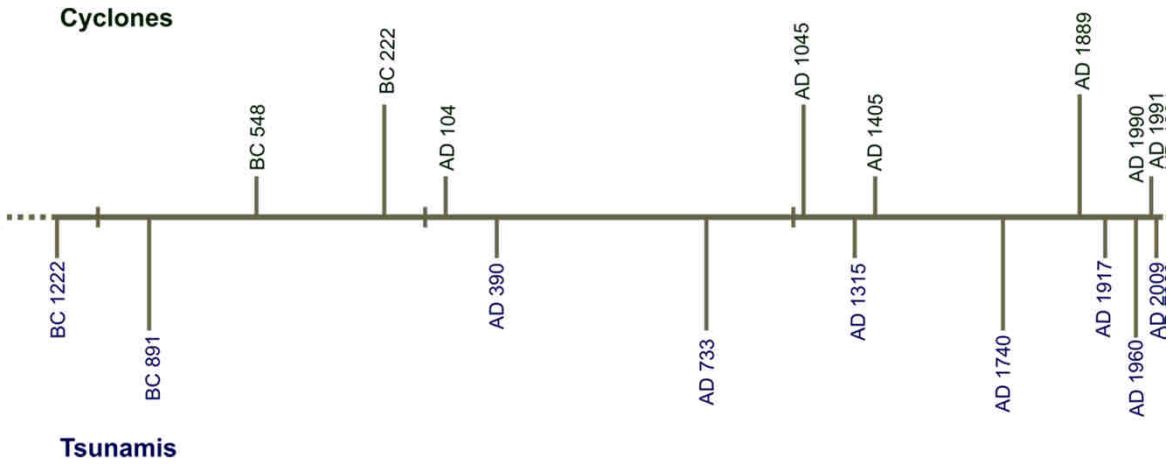
[Demonstration only – i.e. currently in revision]





Deposits study

Long-term Tsunami & Cyclone history from the sedimentary record



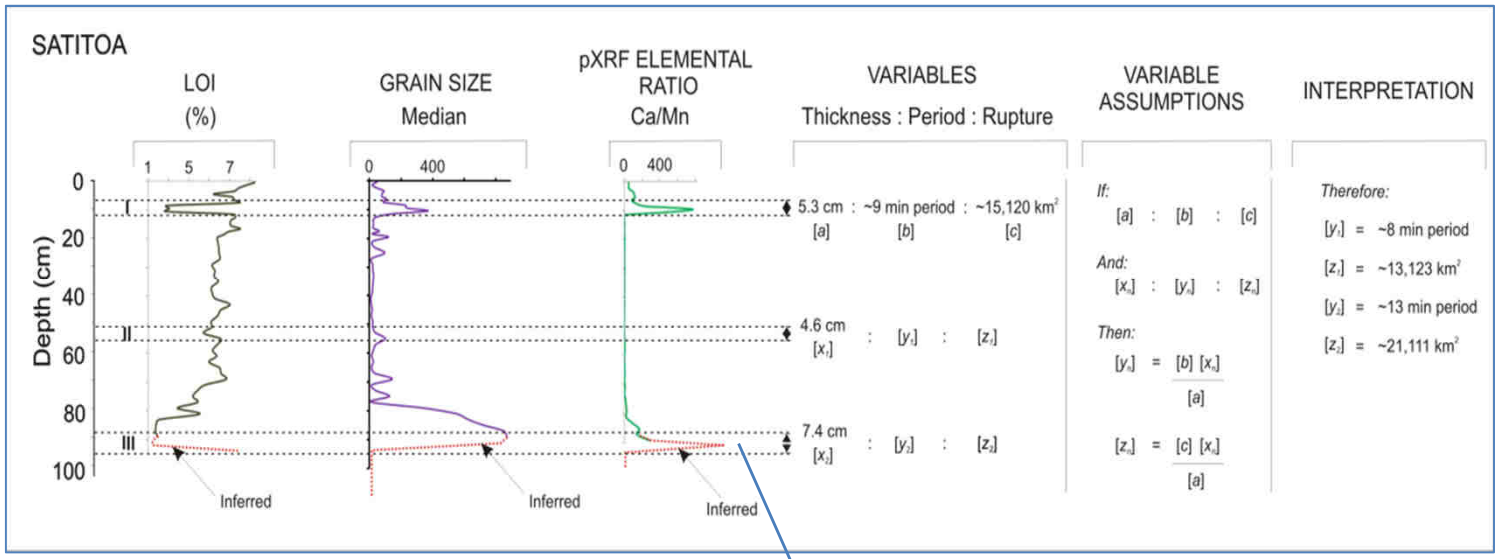
Deposits study

Tsunami frequency estimation

Millennium	Tsunami Age (Known or Inferred)	Uncertainty Distribution		Lag Interval (years)[1]	Uncertainty Lag (years)		Uncertainty Lag Range (years)[4]
		Maximum	Minimum		Maximum[2]	Minimum[3]	
3rd AD	2009	na	na				
				92	na	na	na
2nd AD	1917	na	na				
				157	227	87	140
	1760	1690	1830				
				426	631	221	410
	1334	1199	1469				
				618	967	269	698
1st AD	716	502	930				
				341	683	0	683
	375	247	502				
				1304	1622	985	637
1st BC	929	1120	738				
				319	637	0	637
2nd BC	1248	1375	1120				
			MEAN	465	795	260	534
			MEDIAN	341	660	154	506
			MEAN (Excluding Outlier)	326	629	115	514
			MEDIAN (Excluding Outlier)[5]	**330**	**637**	**87**	**550**

Deposits study

Tsunami magnitude estimation



AD 1690 – 1830 TSUNAMI = Magnitude ~8.2 (Near-simultaneous?)

Deposits study

Hazard context

2009 Tsunami Impacts Analogue

Coastal destruction on SE Upolu.

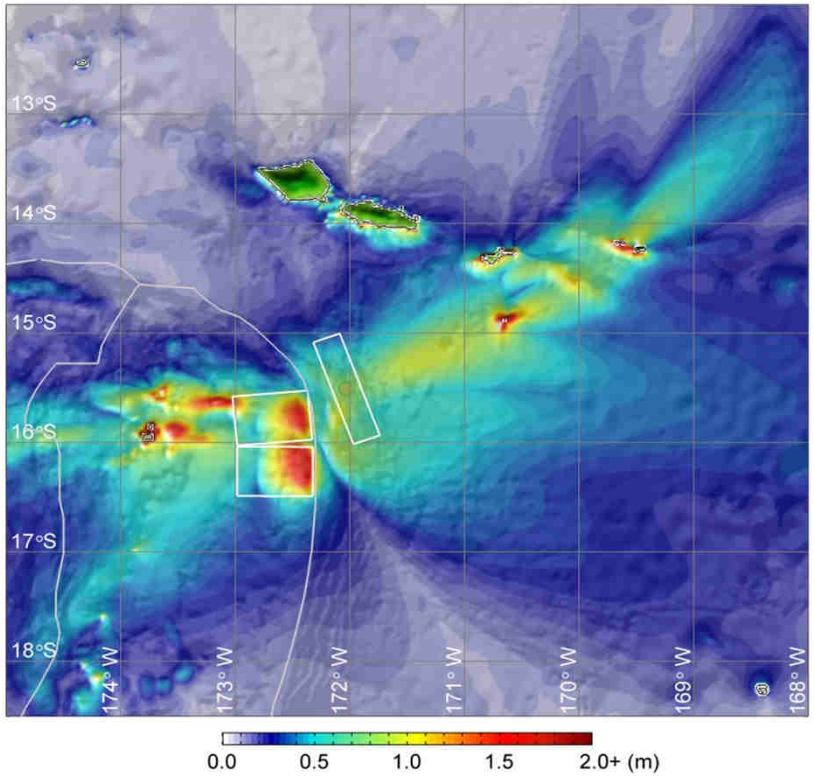
Loss of life (e.g. young & elderly).

Coastal abandonment e.g. Saleapaga village.

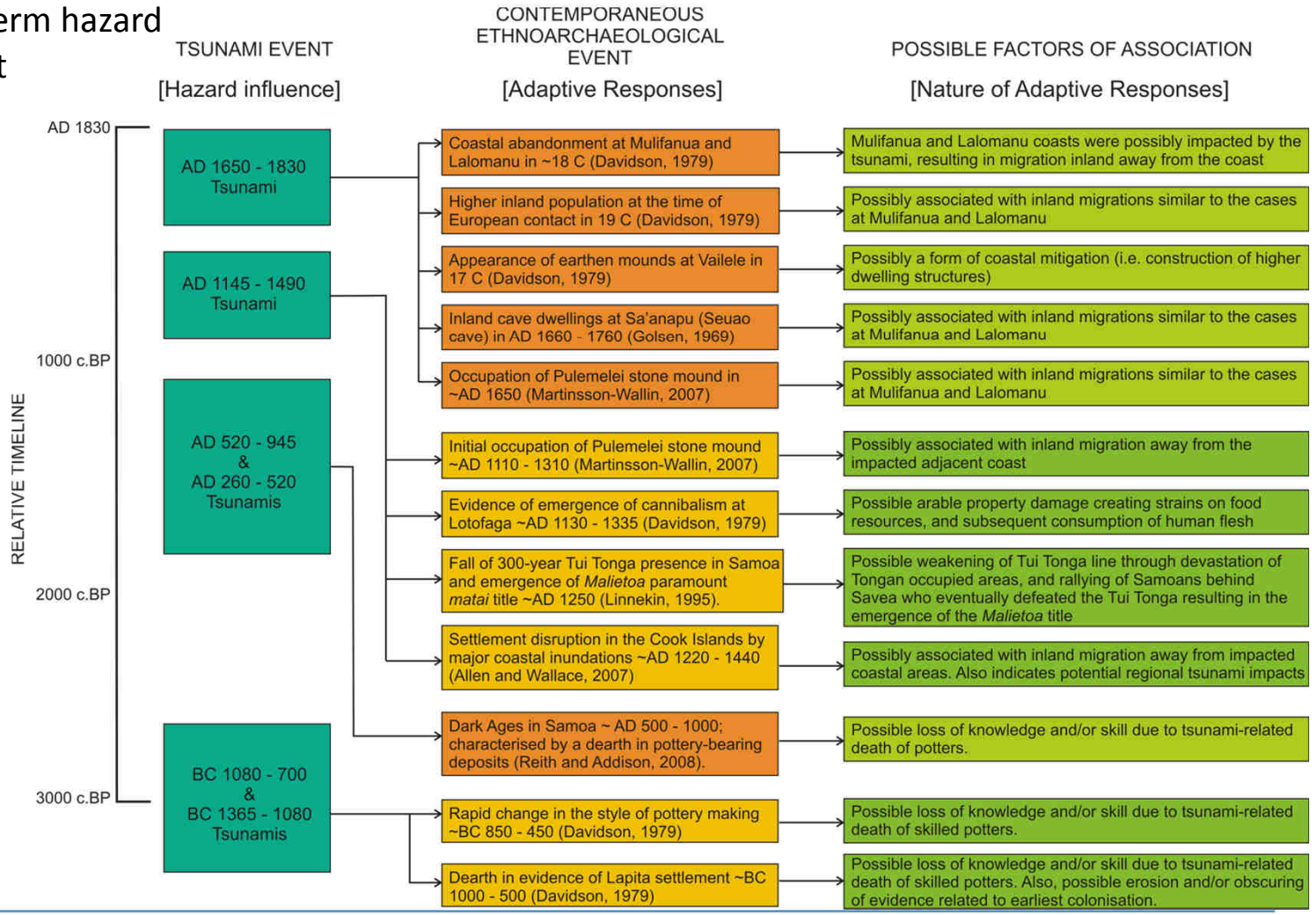
Property destruction and food shortage.

Lifeline destruction.

Psychological impacts.



Long-term hazard context

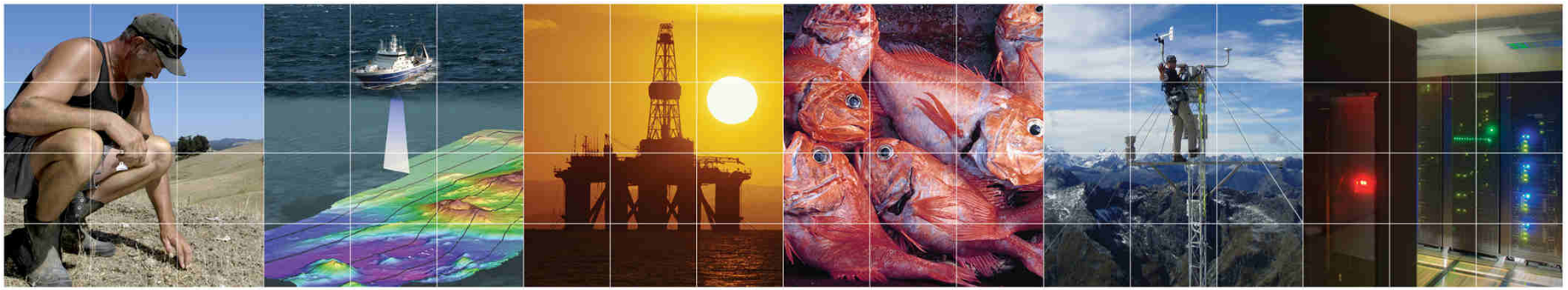


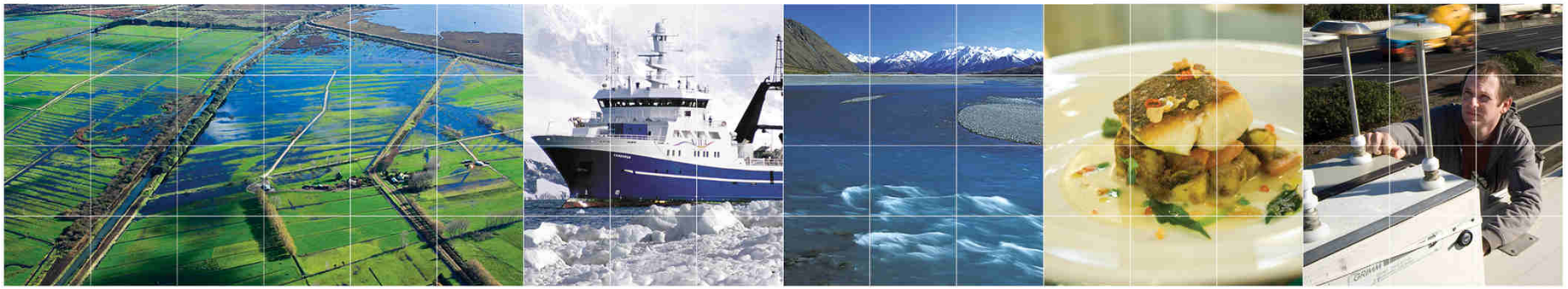
Conclusions & Applications

- Long-term understanding of tsunamis in Samoa: **frequency, magnitude, sink-to-source, hazard context**
- Investigative techniques **can be applied** to other island contexts & regionally:
  - Understanding frequency, magnitude, hazard.
  - Ground-truth/corroborate numerically modelled inundation scenarios.
  - Develop palaeotsunami inundation hazard models for longer-term risk assessment.

Conclusions & Applications

- **Complements an understanding of palaeo-cyclones** and associated hazards (e.g. flooding), and potentially palaeo-climate.
- Complements an understanding of environmental/coastal change.
- **Local to regional scales**.
- … *All within the context of building resilience!*



NIWA
Taihoro Nukurangi

Thank you