

Risk posed by landslide generated tsunamis near southern Taiwan

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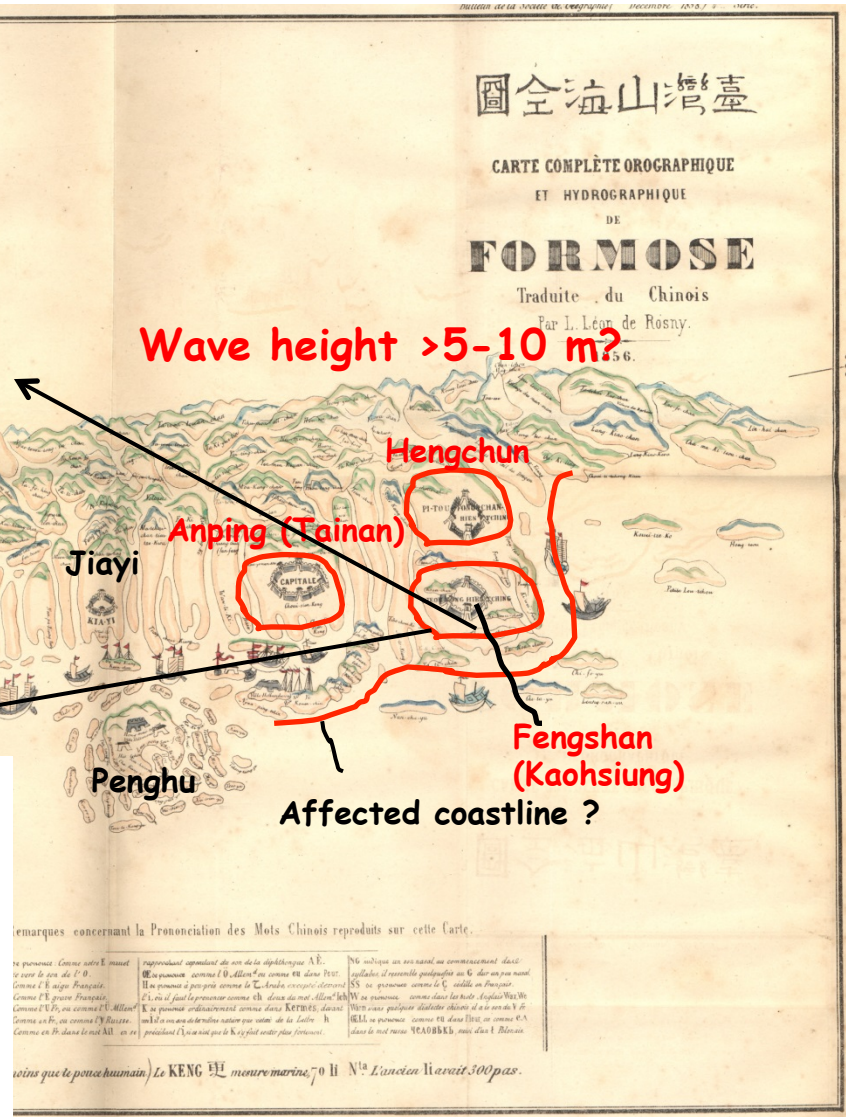
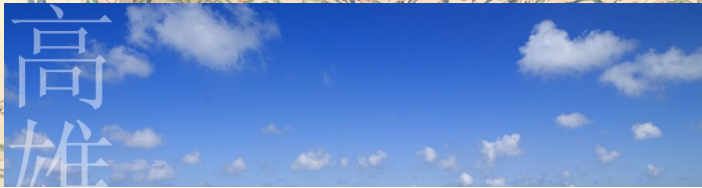
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Who cares?



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1. Tsunami risk in this area?
2. Is southern Taiwan threatened by such extreme events?
3. Could it happen again?

1856 map of Taiwan published by the Royal Scottish Geographical Society in 1896

Spatial distribution – NE SCS

Tsunami locations based on historical records:

~3 both coasts

~13 mainland China

~22 Taiwan

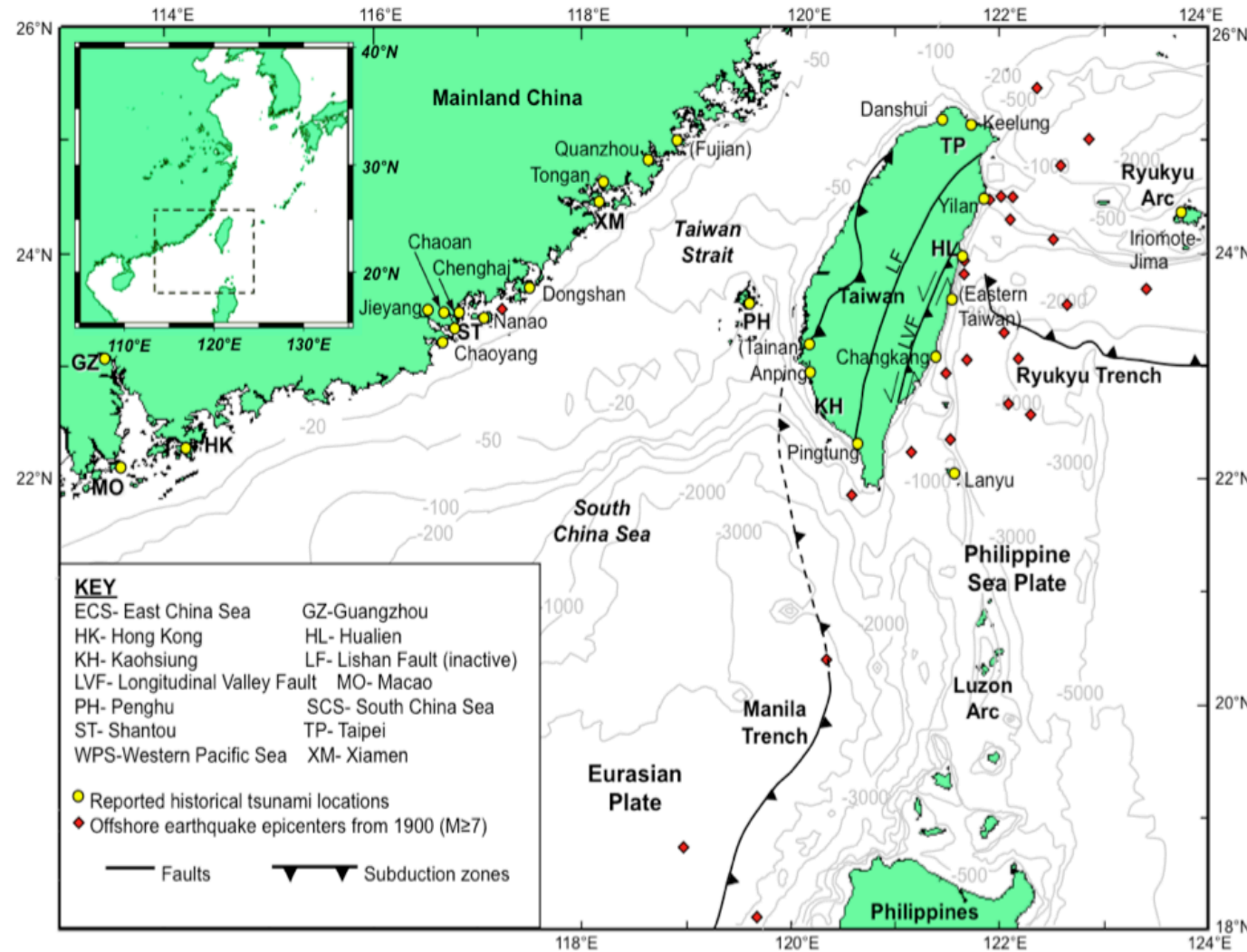
(eastern coast mostly affected)

~2 Japan (affected by earthquakes from TW area)

Source location:

~34 local

~14 regional (+2 'far source')



Lau et al., NHESS, 2010

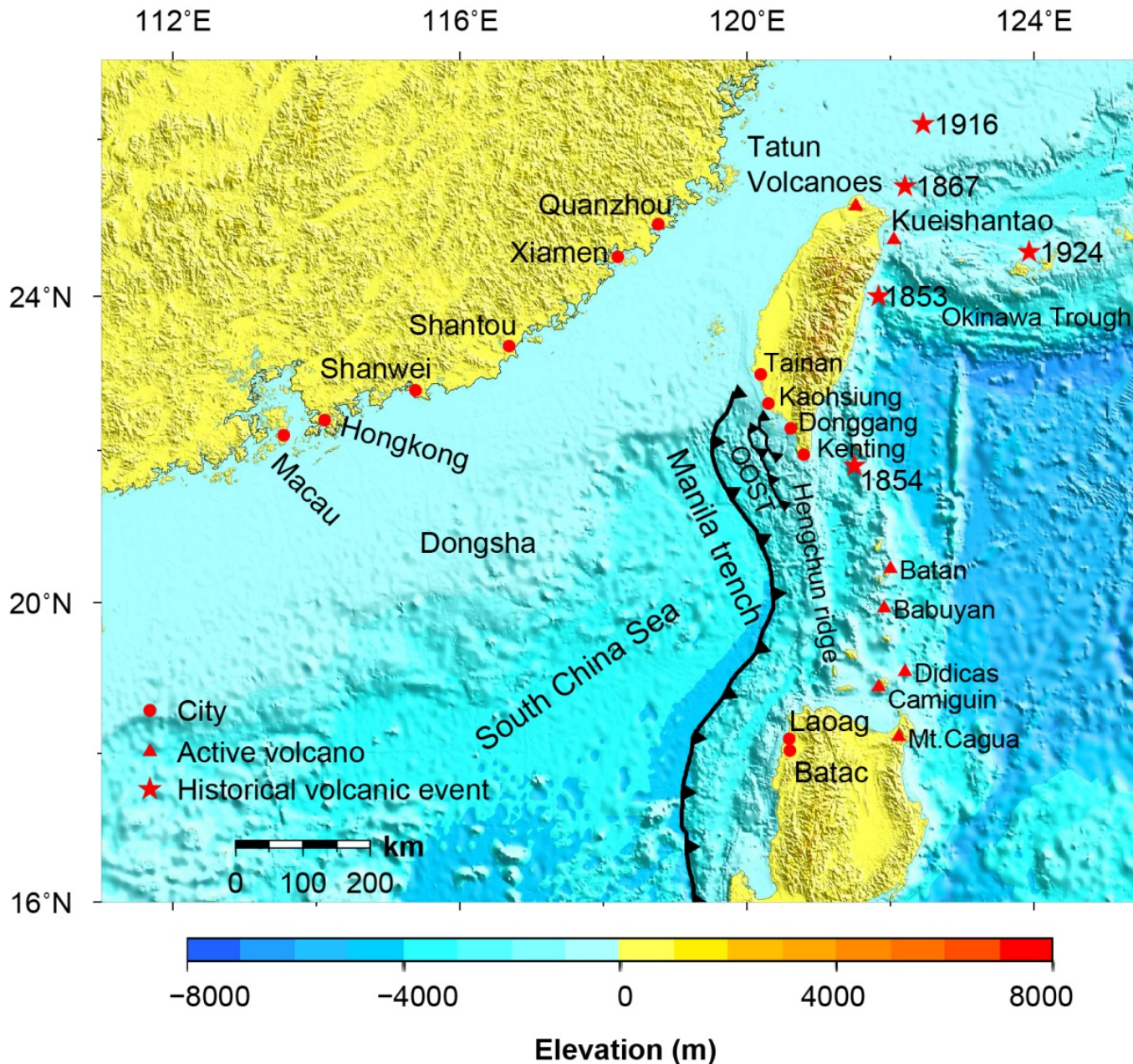
Summary of the historical records indicating a late 18th Century event

Records	Time	Source	Affected area	Wave height	Casualty
A [Mallet, 1854] In English	1782 May 22	N.A	All the villages along the Formosa coast	>5-10 m	immense numbers of people
B [Perrey, 1862] In French	1782 May/Oct? Or 1682 Dec?	Volcanic eruption	3 main cities, 20 villages	>5-10 m	> 40,000
C [Chen, 1830] In Chinese	1781 May~June	N.A	Dapeng Bay, Donggang town, Pingtung	>3-5 m	1 or more ?
D [Soloviev and Go, 1974] In Russian with English version	1782 May 22	Earthquake	3 main cities, 20 villages	>5-10 m	> 40,000

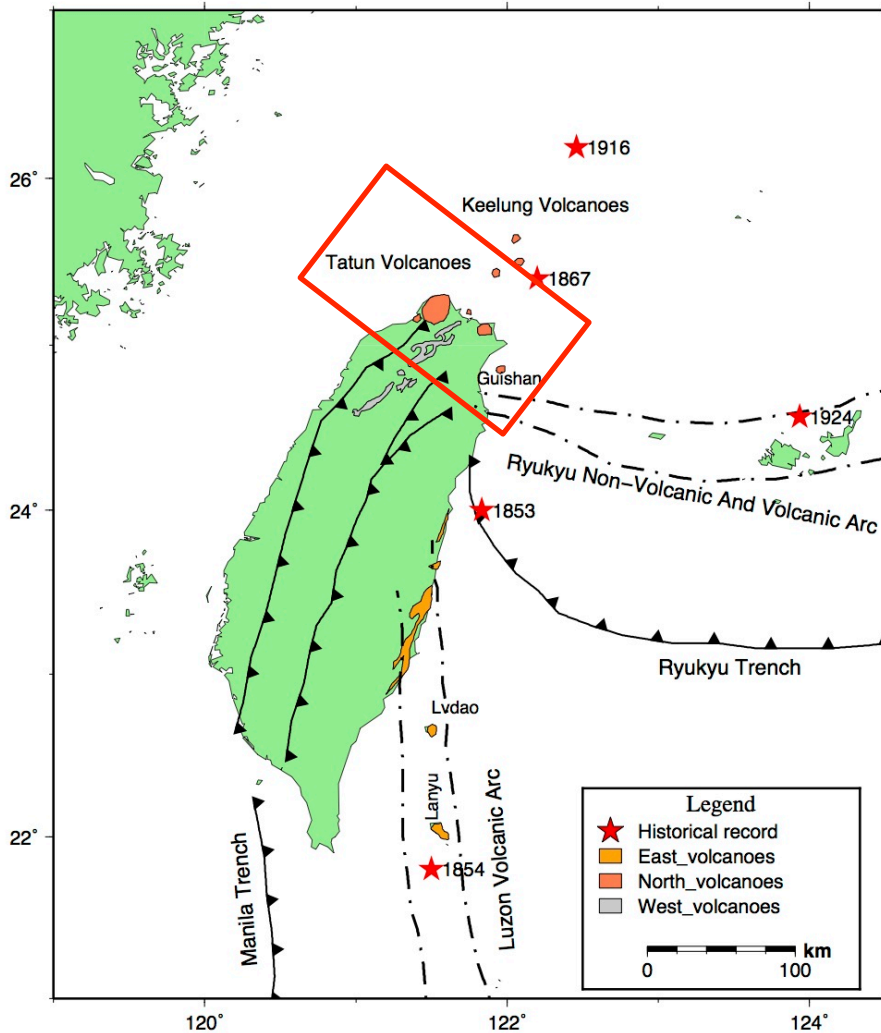
Possible sources:

- Volcano?
- Earthquake?
- Submarine Mass Failure (SMF)?

What do we know?



Could the 18th C event be from a volcanic eruption?



The volcano distribution map of Taiwan and historical volcanic eruption events, Figure modified from http://volcano.gi.ntu.edu.tw/worldwide/taiwan_volcanomap.htm, accessed on 1 Jun, 2014

○ Volcanoes in Taiwan:

- Guishan Island (7000 years ago) (Huang, 2012)
- Tatun Volcano Group (5000 years ago) (Konstantinos et al., 2007; Belousov et al., 2010)
- Keelung Volcano Group
- Guanyin Mountain
- Caoling Mountain
- Coast Mountains
- Lvdao Island
- Lanyu and Pescadores

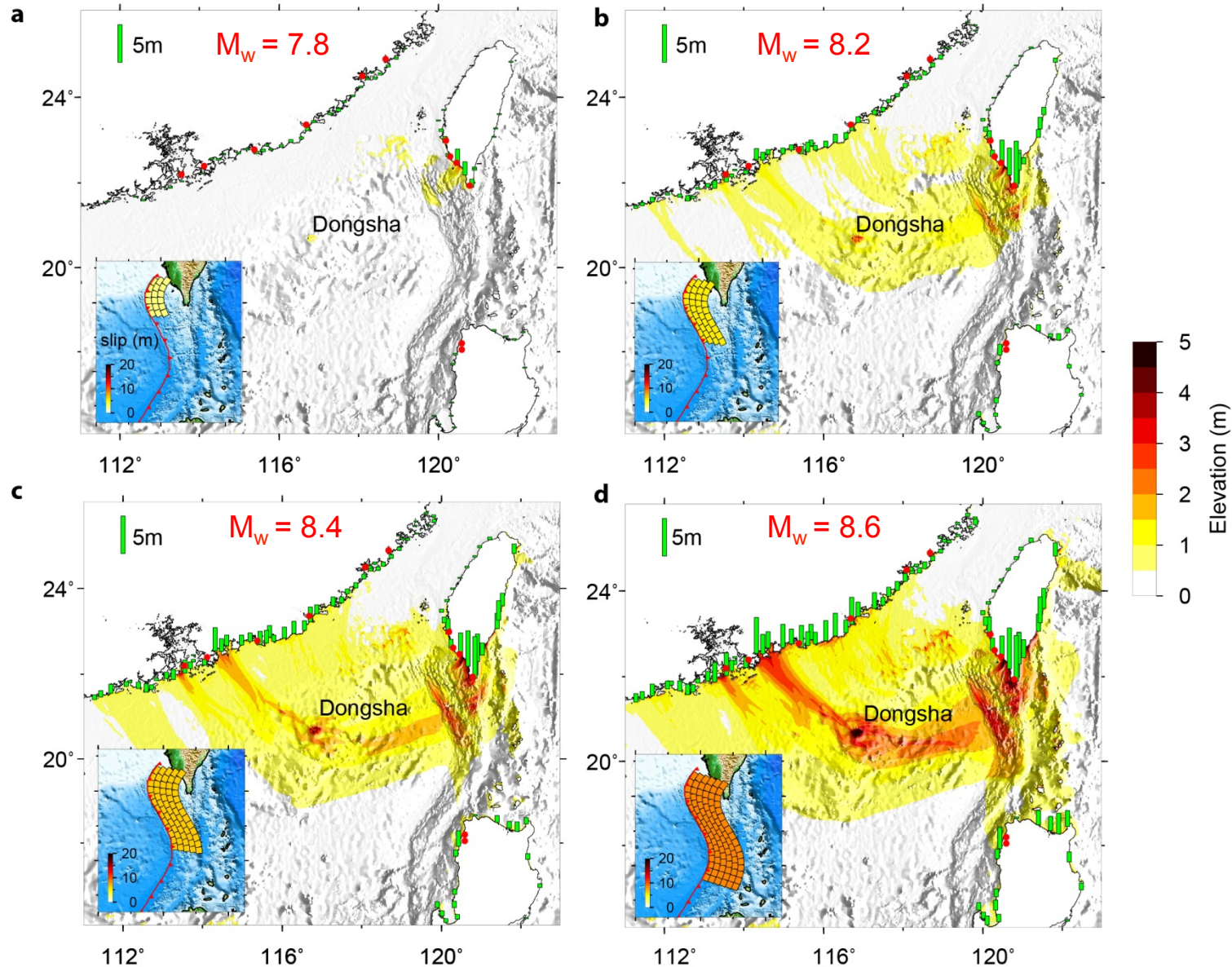
○ Submarine volcanoes: (Huang, 2012)

- historical events (Chen and Shen, 2005)

○ Volcanoes in the Luzon Strait: (Paris et al., 2014)

- Babuyan
- Didicas
- Camiguin
- Batan

Tsunami generated by synthetic earthquakes? with uniform slip distribution and different magnitude

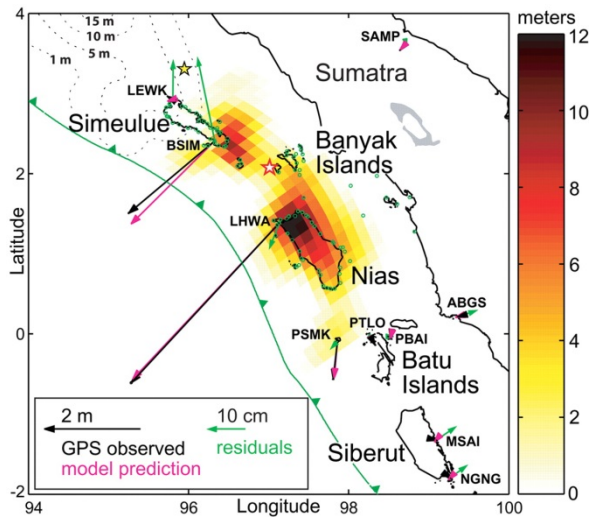


Slip distribution for different M_w earthquakes and simulated maximum surface elevation

Does non-uniform slip distribution play a role?

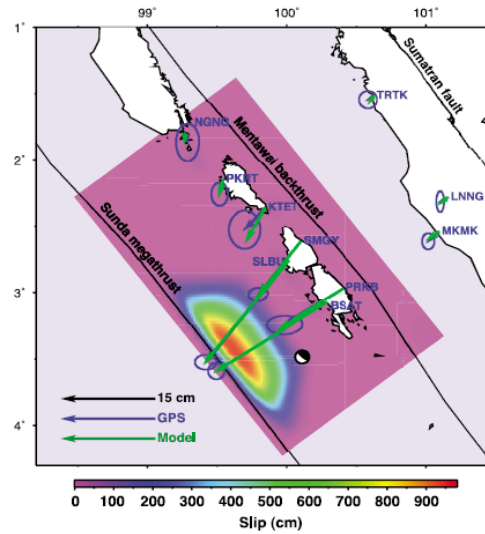
Mw=8.7

3 m tsunami wave height



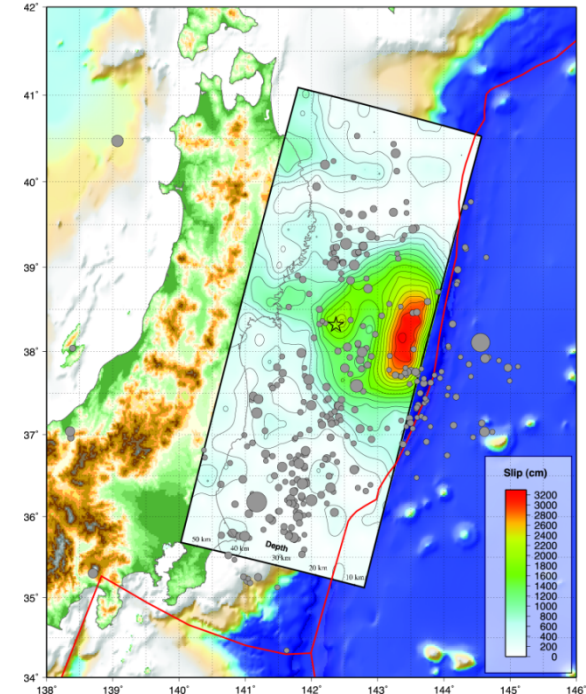
Mw=7.8

16 m tsunami wave height



Mw=9.0

> 40 m tsunami wave height



Coseismic slip distribution on the 28 March 2005 Nias-Simeulue fault plane (Briggs et al., 2006)

Inversed slip distribution for the 2010 Mentawai Earthquake (Hill et al., 2012)

Big earthquake \neq Large tsunami wave

The slip distribution of the 2011 Tohoku earthquake superimposed on GEBCO bathymetry

http://earthquake.usgs.gov/earthquakes/eqinthenews/2011/usc0001xgp/finite_fault.php

, accessed on 15 Jul, 2014

So where are we now?

Not a volcano

and

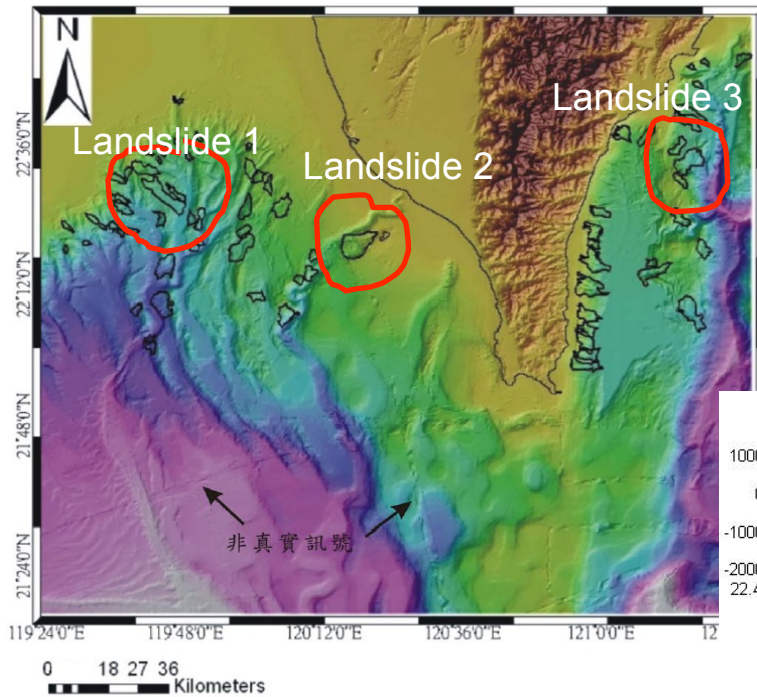
**No earthquake scenario can produce the tsunami
indicated by the historical records**

Remember!

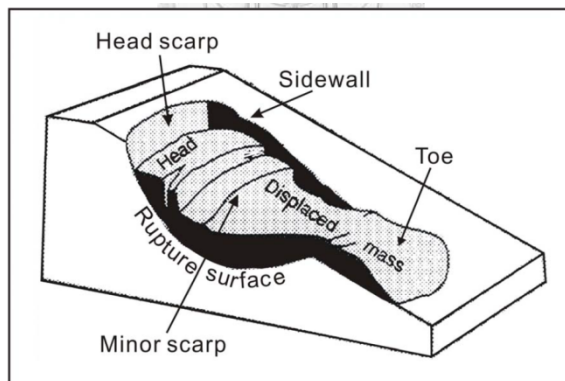
To create a tsunami, you just need to vertically displace the water column.



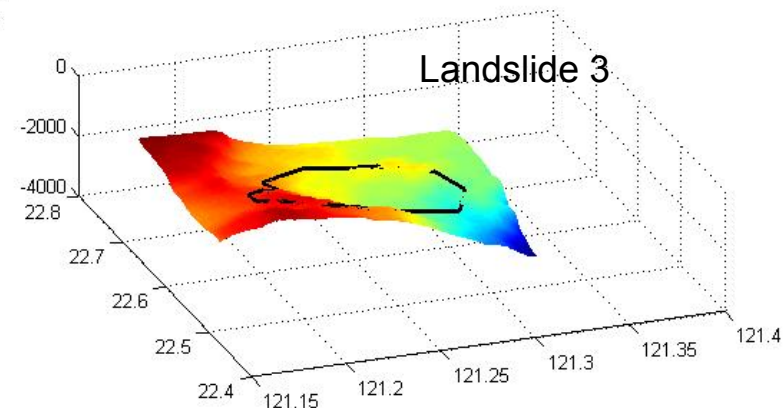
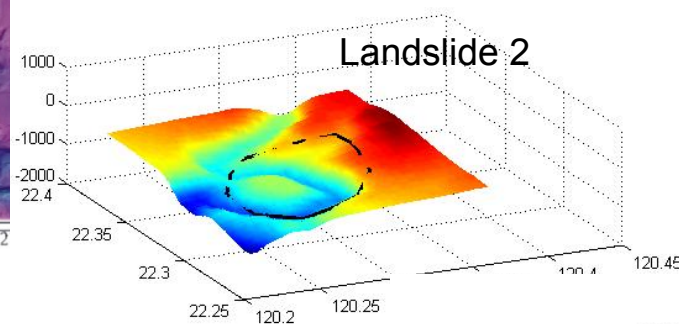
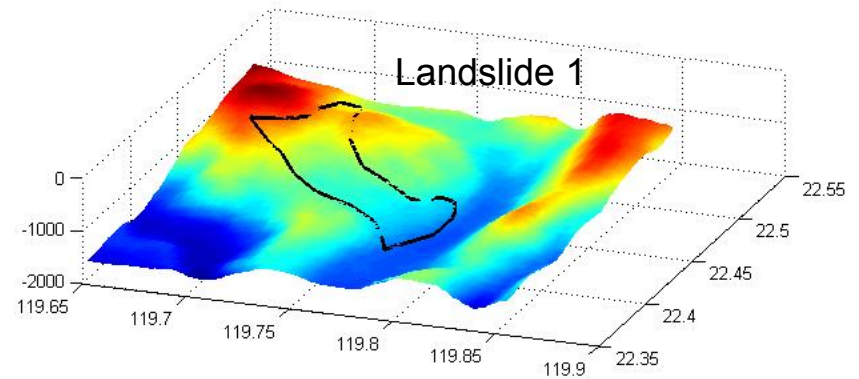
Tsunami generated by Submarine landslide?



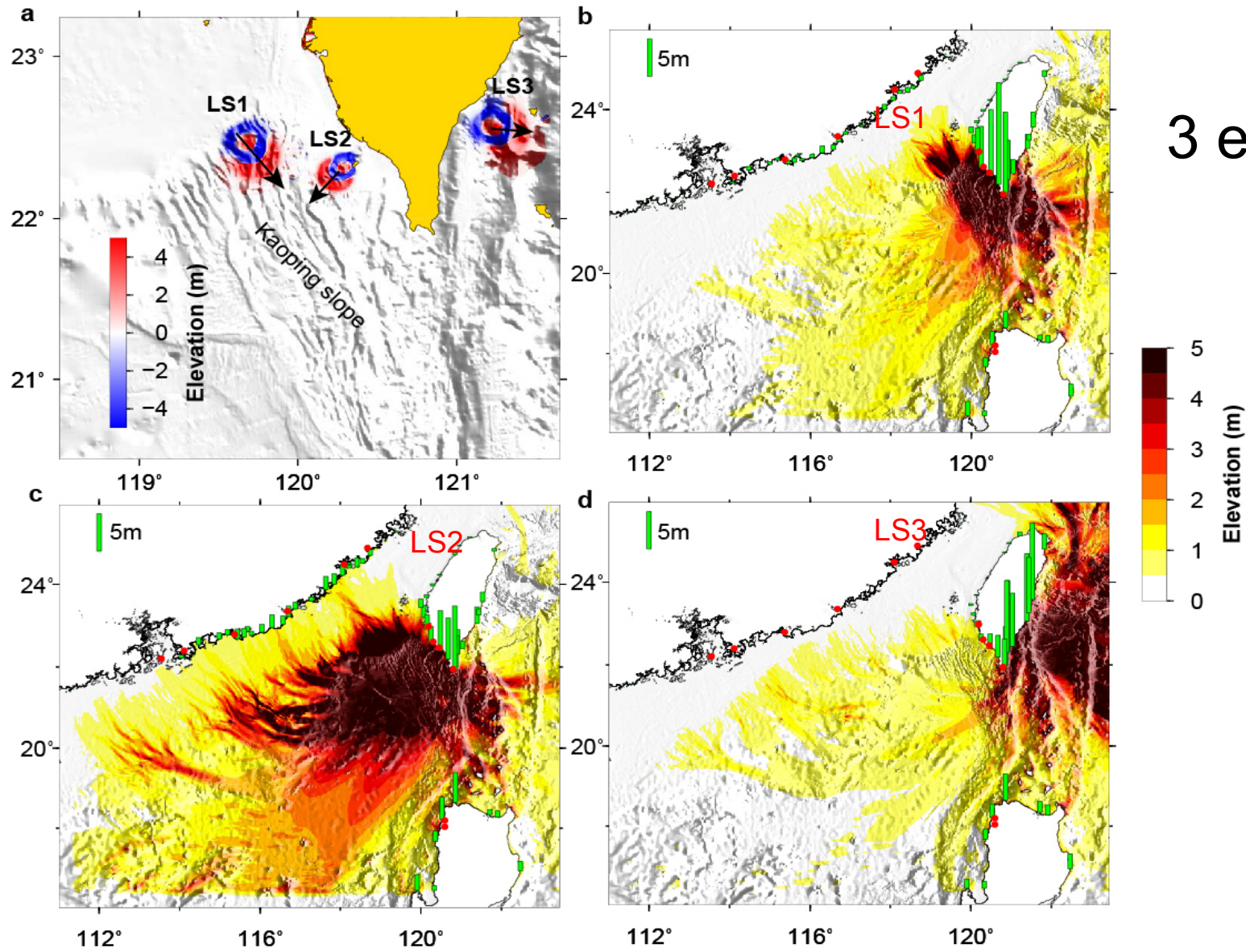
Possible submarine landslides identified by Wu (2008)



Varnes (1978)



Tsunami generated by submarine landslide



3 examples

Conclusions and implications

Late 18th century event -

- ✚ Volcanic eruption? **Not likely**
- ✚ Megathrust earthquake? **Less likely**
- ✚ Submarine landslide? **Most likely**

Risk

- ✚ Tsunami risk on southwest Taiwanese coast: submarine landslide or trench type earthquake
- ✚ Tsunami risk on southeast Chinese coast: trench type earthquake
- ✚ Tsunami wave height: 5-10 m or more in Tainan cannot be reproduced using earthquakes only.

Acknowledgements

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