Assessing the tsunami hazard to Taiwanese coastal infrastructure

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Why is this important?

Not just for Taiwan. Tsunamis affecting Taiwan also affect other coasts.

www.sciencealert.com

How do we plan for catastrophes with 500 or 1000 year return intervals?

Minami, Sanriku,
Japan 2011

Da Nang, Vietnam 2006

Hinchinbrook Marina,
Australia 2011

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Why should we think about risk?

Fukushima Nuclear Power Plant, Japan

Aerial view soon after explosions in reactor halls

(Image*: KeystoneUSA-ZUMA/Rex Features* from: http://www.newscientist.com/blogs/shortsharpscience/2011/04/plan-to-shut-down-fukushima-in.html [accessed, 19/02/2013])

Recent aerial view, February 2013

(Kyodo News, 2013 from: http://fukushimaupdate.com/recent-aerial-view-of-fukushima-i-nuke-plant/ [accessed 19/02/2013])

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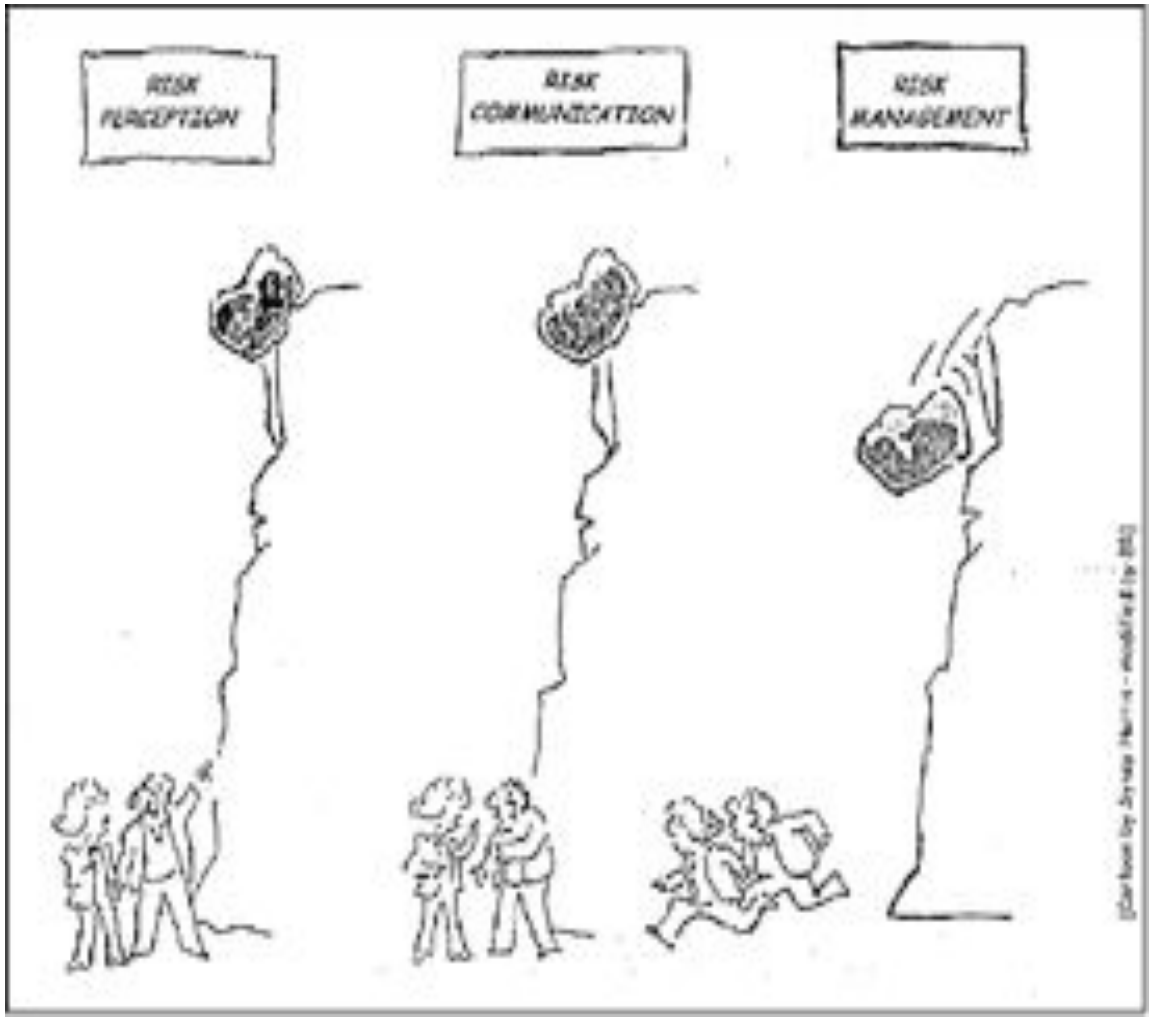
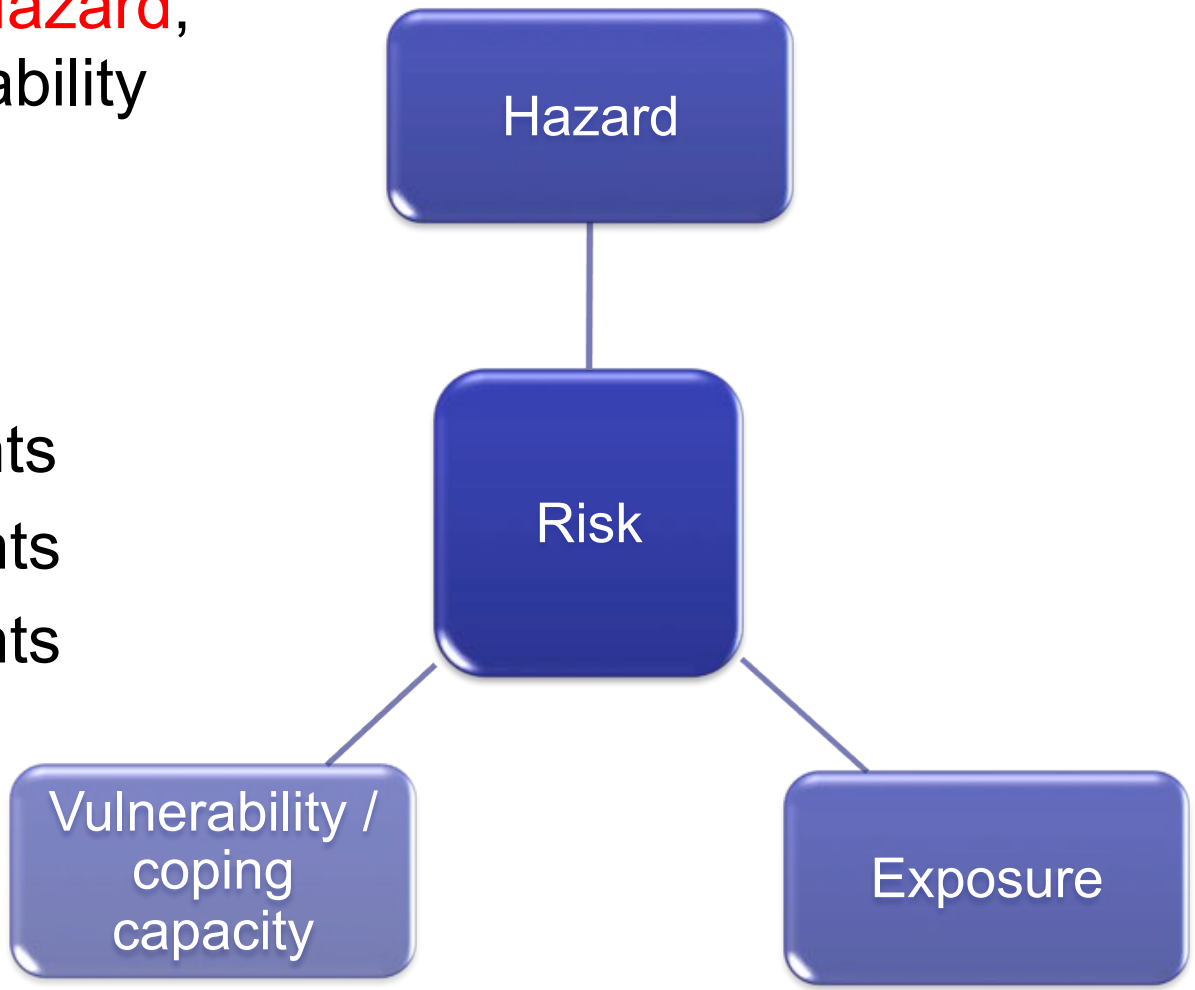
Risk

- How do we get people to think about risk?
- What are the risks?
- Assessing Risk
- Communicating Risk
  - Hazard and Risk maps
- Using Historic Data
- Using other data sets?



How do we get people to think about risk?

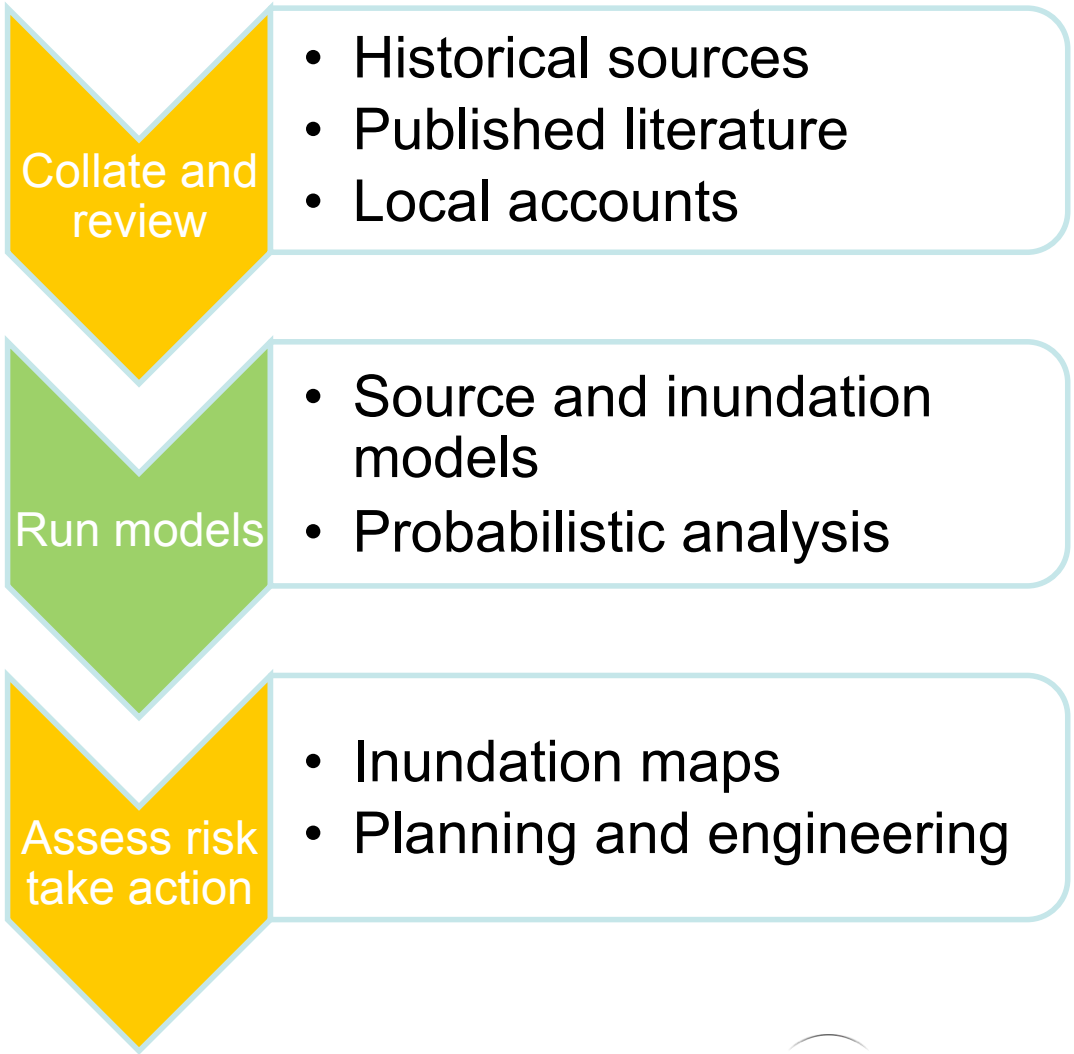
- Risk is a product of Hazard, exposure and vulnerability
- Risk evaluations and assessments
- Probabilities
  - 1 in 20 years events
  - 1 in 100 year events
  - 1 in 500 year events



Why palaeotsunami studies are important

The primary methods for assessing the hazards of coastal development include:

- Searching, summarising and evaluating published research
- Analysing local, regional and national historical records
- Relying on 'past' experiences in the region



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Using geology / geomorphology

Lack of understanding = CONSIDERABLE RISK

Analysis of modern storm and tsunami event dynamics

Analysis of modern storm and tsunami sediment deposits

Sedimentology and hydrodynamics

Analysis of ancient events

End goal - Safer coasts in Asia

Driving research aim:

Safer coasts through increased understanding

Geological record gives long term recurrence intervals

Climate change + increased storminess?

IOT tsunami deposits, India

Ancient sand deposits, Thailand

Modern processes

IOT tsunami deposits, Thailand

Ancient deposits

Ancient boulder deposits, Australia

?

The information is not good enough

Historical sources

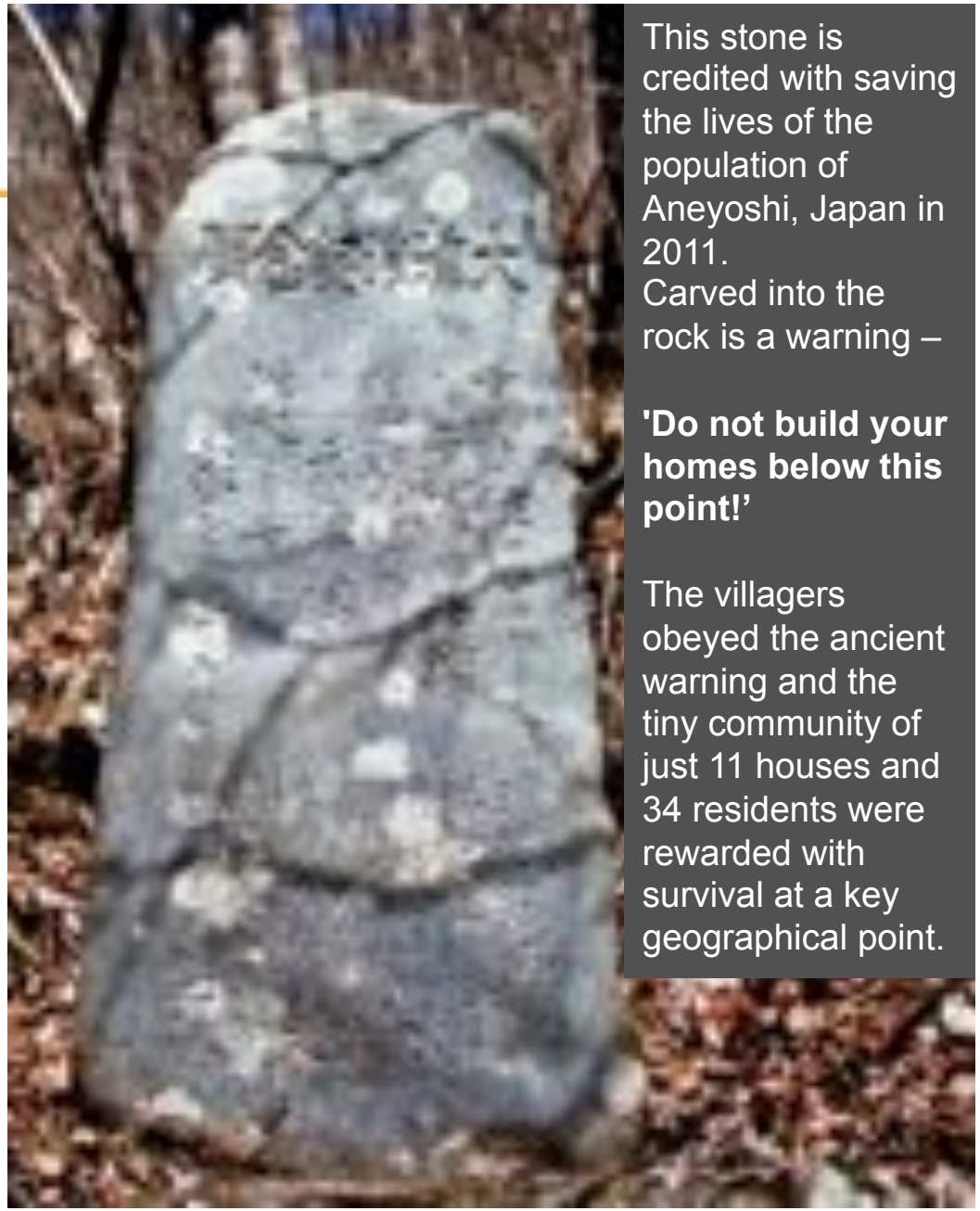
- Even when they are long and detailed (e.g. China/Taiwan) they are often inaccurate (see discussion Lau et al., Nat. Haz. Earth Sys. Sci., 2010)

Published literature

- Considerable debate (e.g. storm v tsunami?) Who has the best model? How do you really test the models?
- Yesterdays news

Local accounts

- Indigenous knowledge, historical accounts are full of inconsistencies
- People exaggerate



This stone is credited with saving the lives of the population of Aneyoshi, Japan in 2011.
Carved into the rock is a warning –

'Do not build your homes below this point!'

The villagers obeyed the ancient warning and the tiny community of just 11 houses and 34 residents were rewarded with survival at a key geographical point.

http://www.dailymail.co.uk/news/article-1379242

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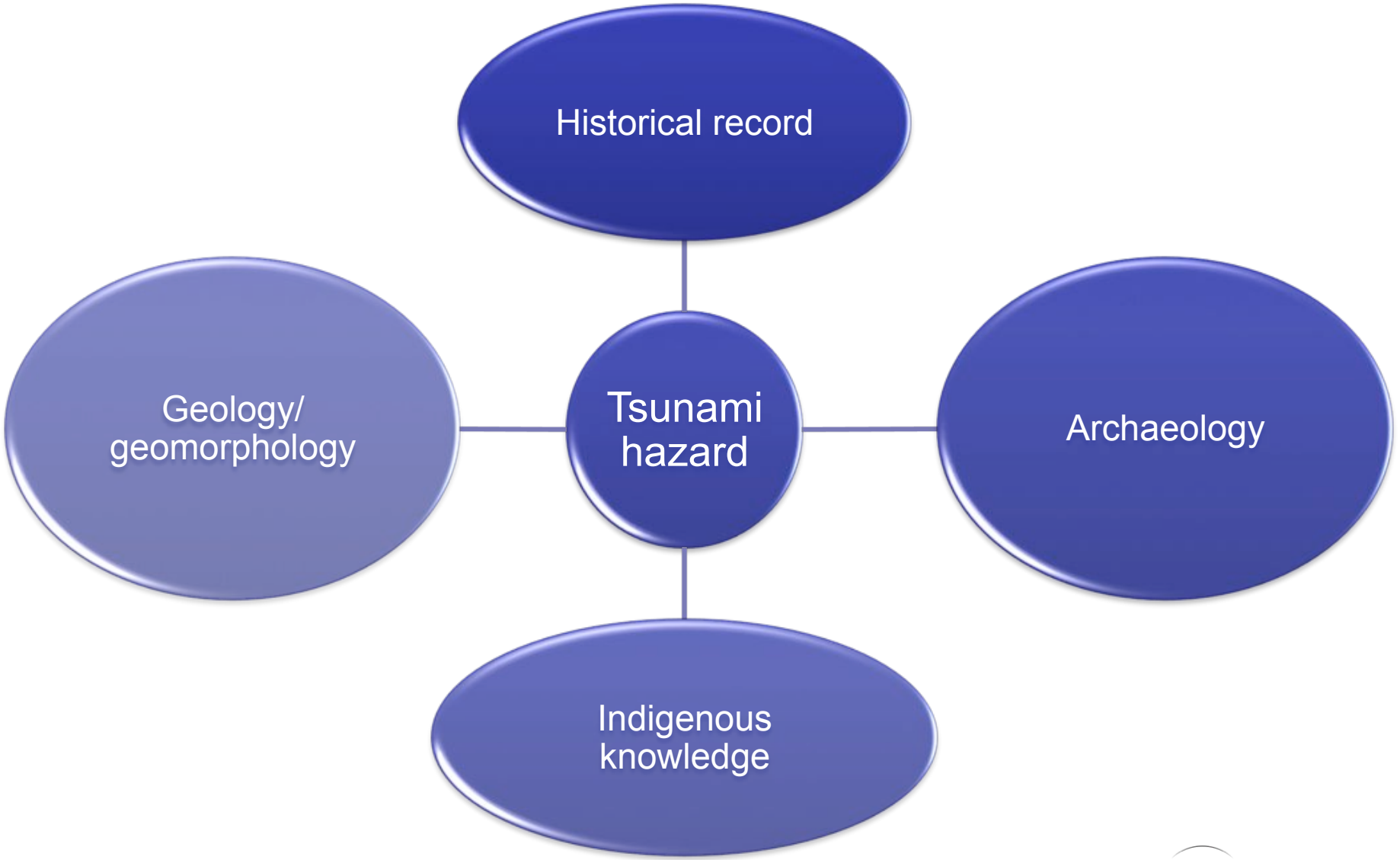
Integrated approach to assessing tsunami hazard



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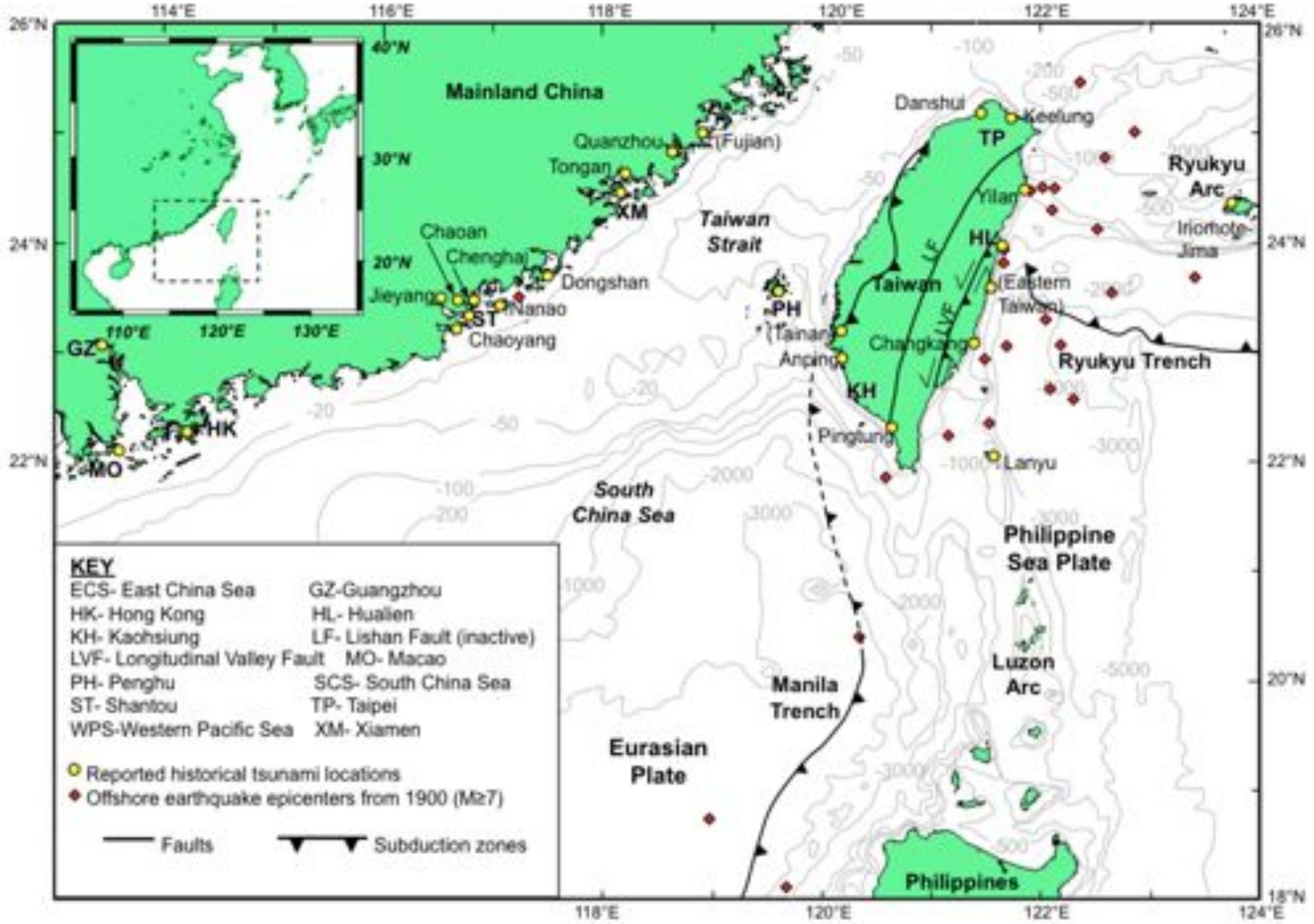
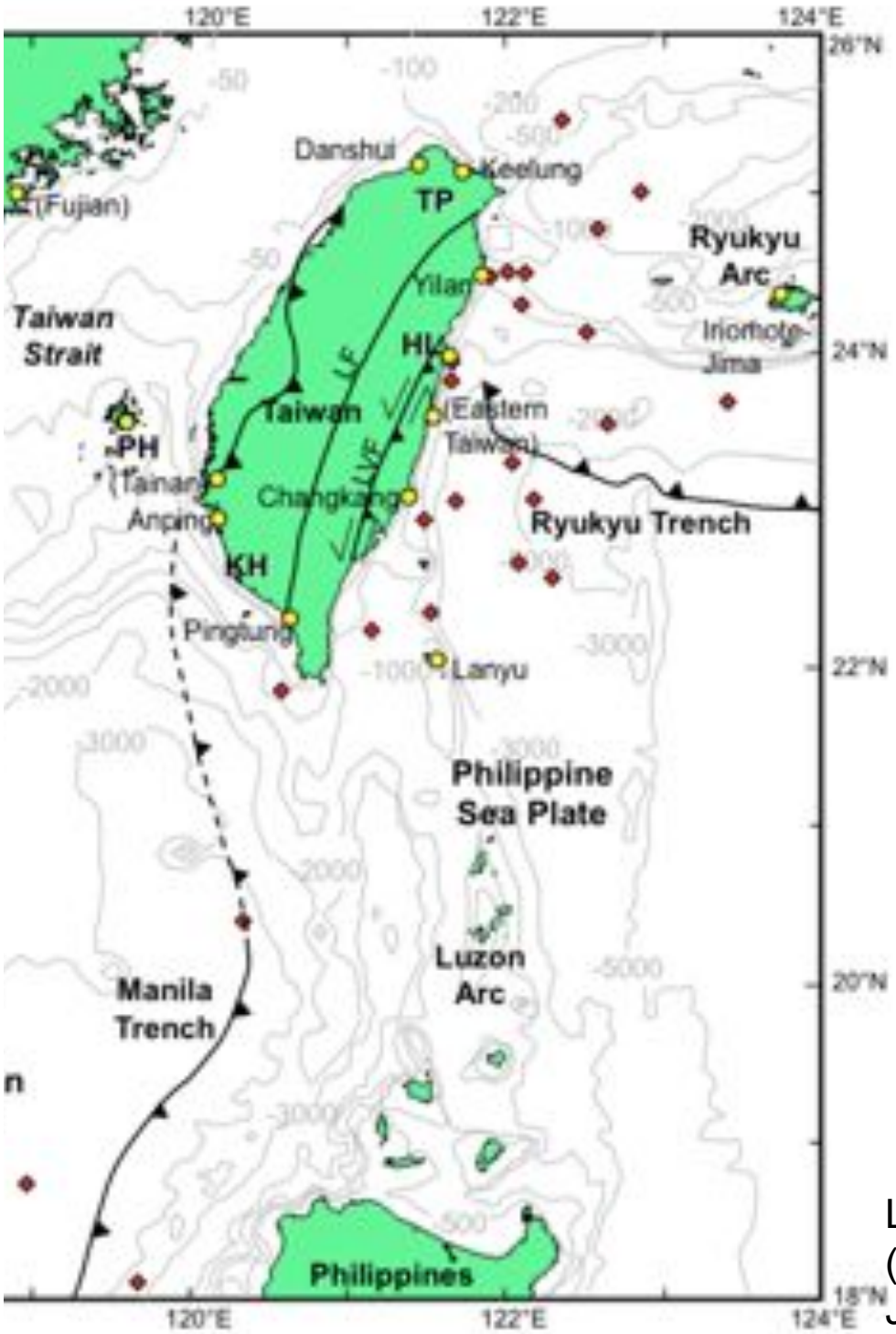
Historical tsunamis



Lau et al., NHESS, 2010 (modified from Shyu et al., JGR, 2005)

Tsunami sources around Taiwan



Tsunami generation mechanisms

- Earthquakes
- Submarine landslides
- Volcanic processes
- Bollide impacts

We need to consider all options

Mak and Chan (2007) made the following description of Tainan event listed for 22 May 1782 (#15): “It was reported that Taiwan was shaken by an earthquake, associated with a flood extended 120 km for inland, and 40 000 casualties was claimed (Perrey, 1862a, cited by Soloviev et al., 1974)” (p. 158).

Lau et al., NHESS, 2010
(modified from Shyu et al., JGR, 2005

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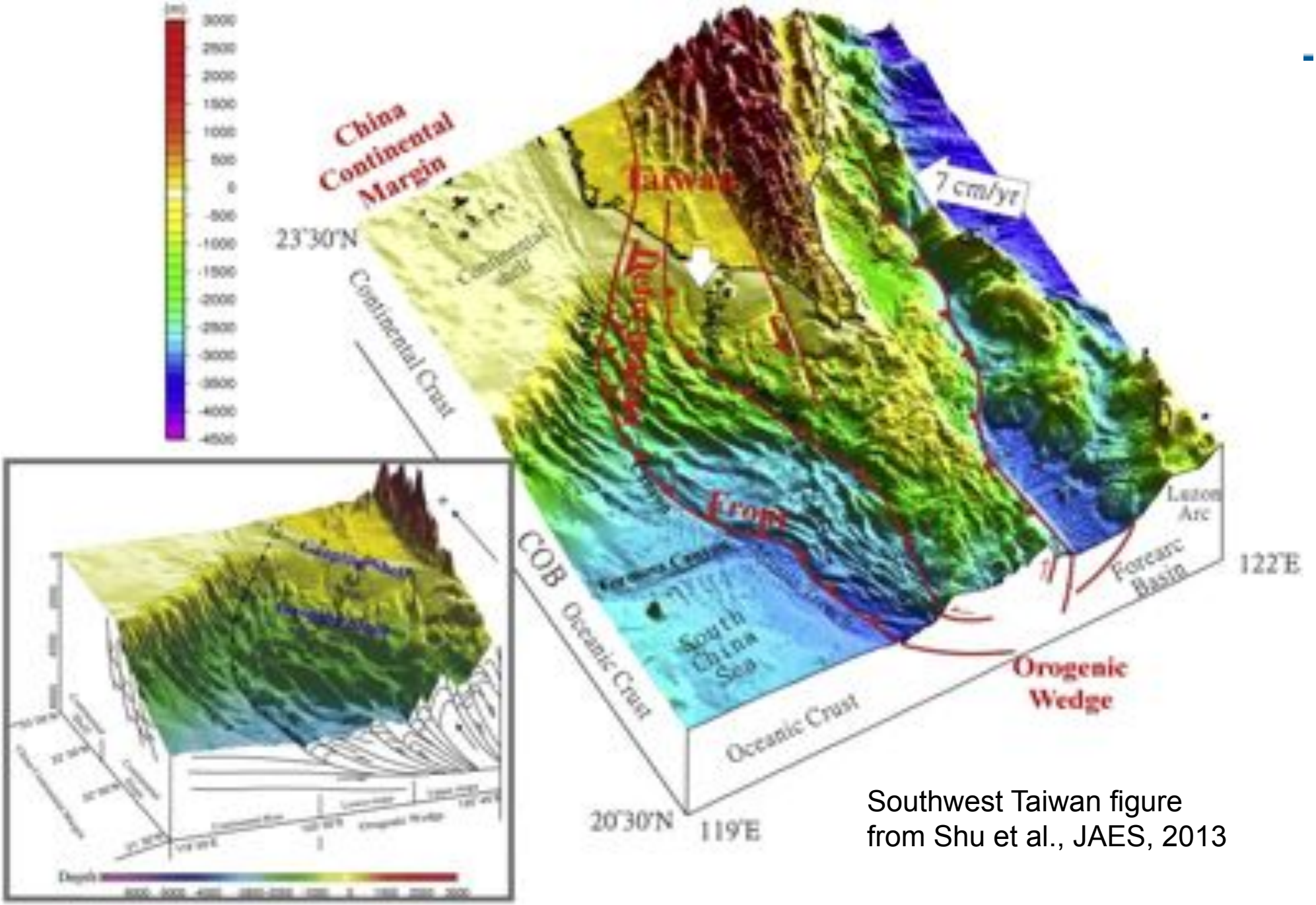
Volcanic tsunamis - Babuyan islands

Smith Volcano, Babayun

Paris et al., in press Natural Hazards

Submarine landslides

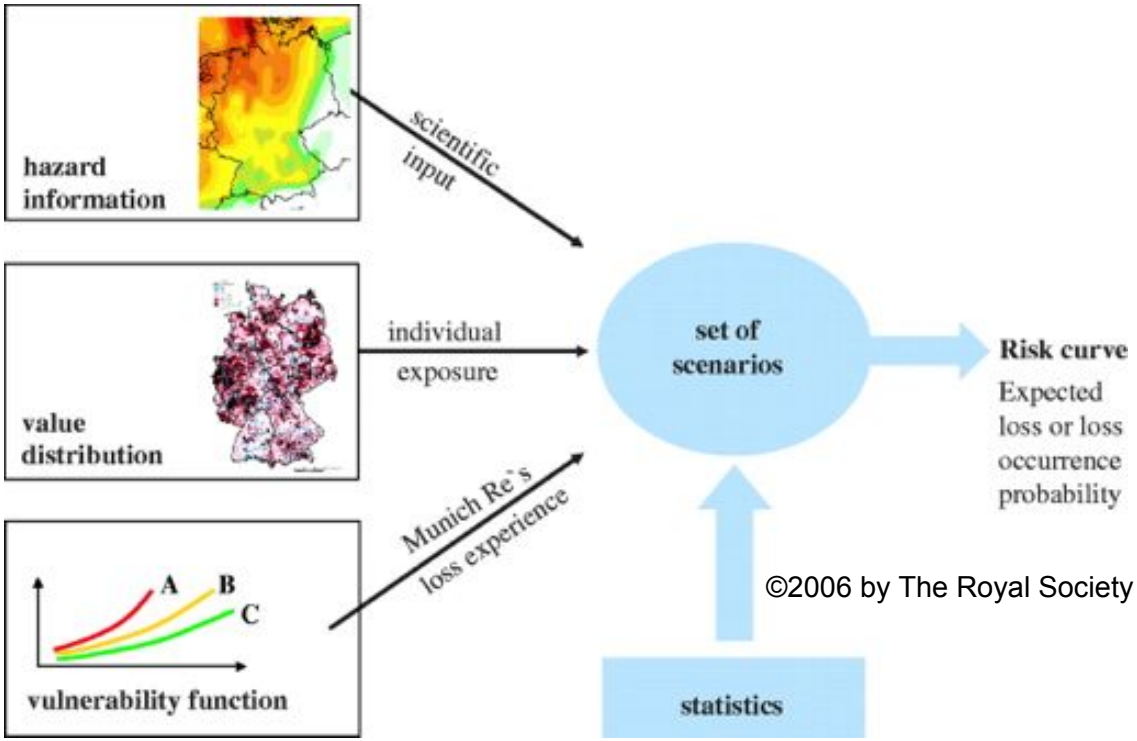


Southwest Taiwan figure
from Shu et al., JAES, 2013

Communicating Risk

Risk and Hazard maps

- Local area
  - greater detail
- Regional to Global
  - Larger area
  - Increased level of generalisation
  - Probabilistic models



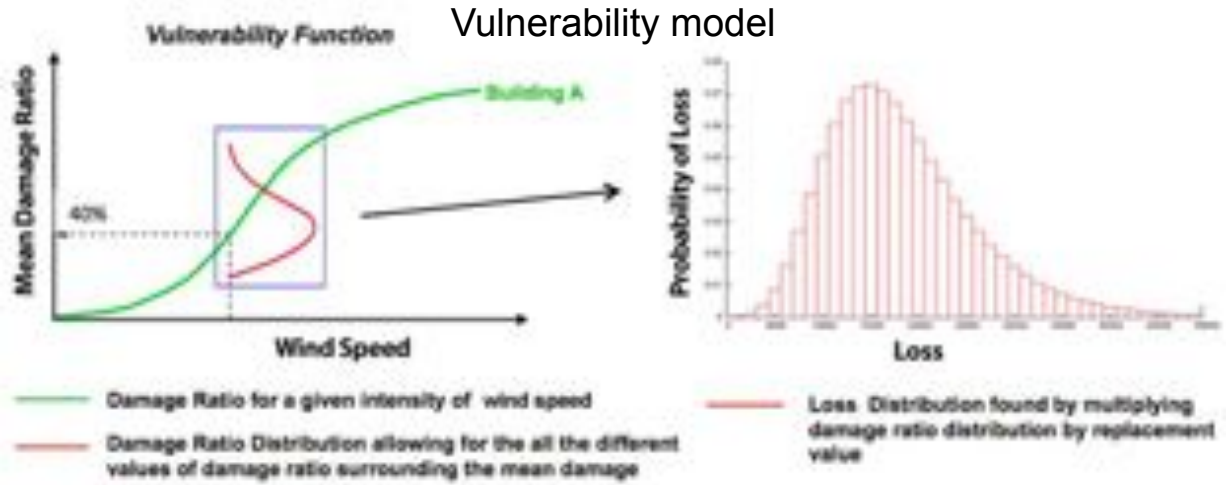
Smolka A Phil. Trans. R. Soc. A 2006; 364:2147-2165

Communicating risk?

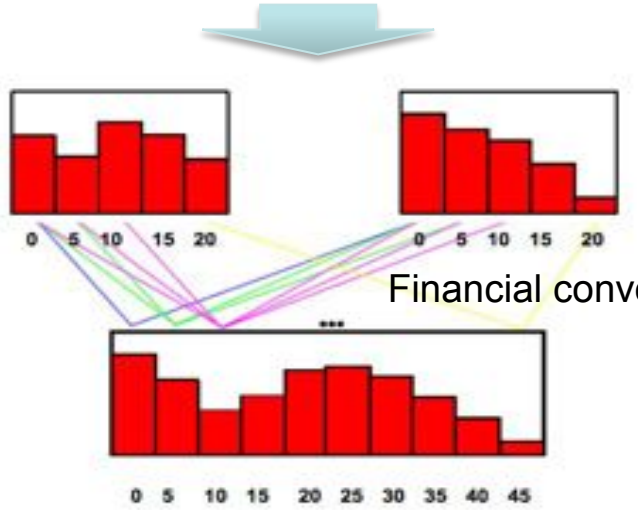
- Risk evaluations and assessments
- Probabilities
  - 1 in 20 years events
  - 1 in 100 year events
  - 1 in 500 year events

We have had 3, 1 in 100 year events in the last 10 years.

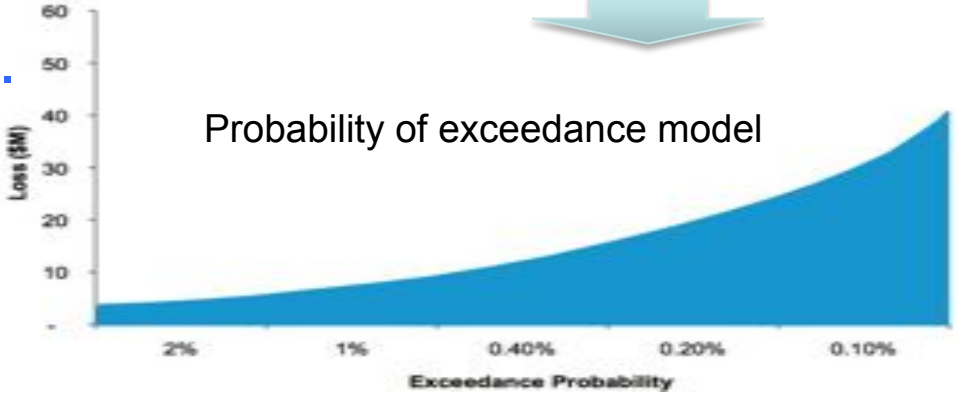
Confusing?



Vulnerability model



Financial convolution model



Probability of exceedance model

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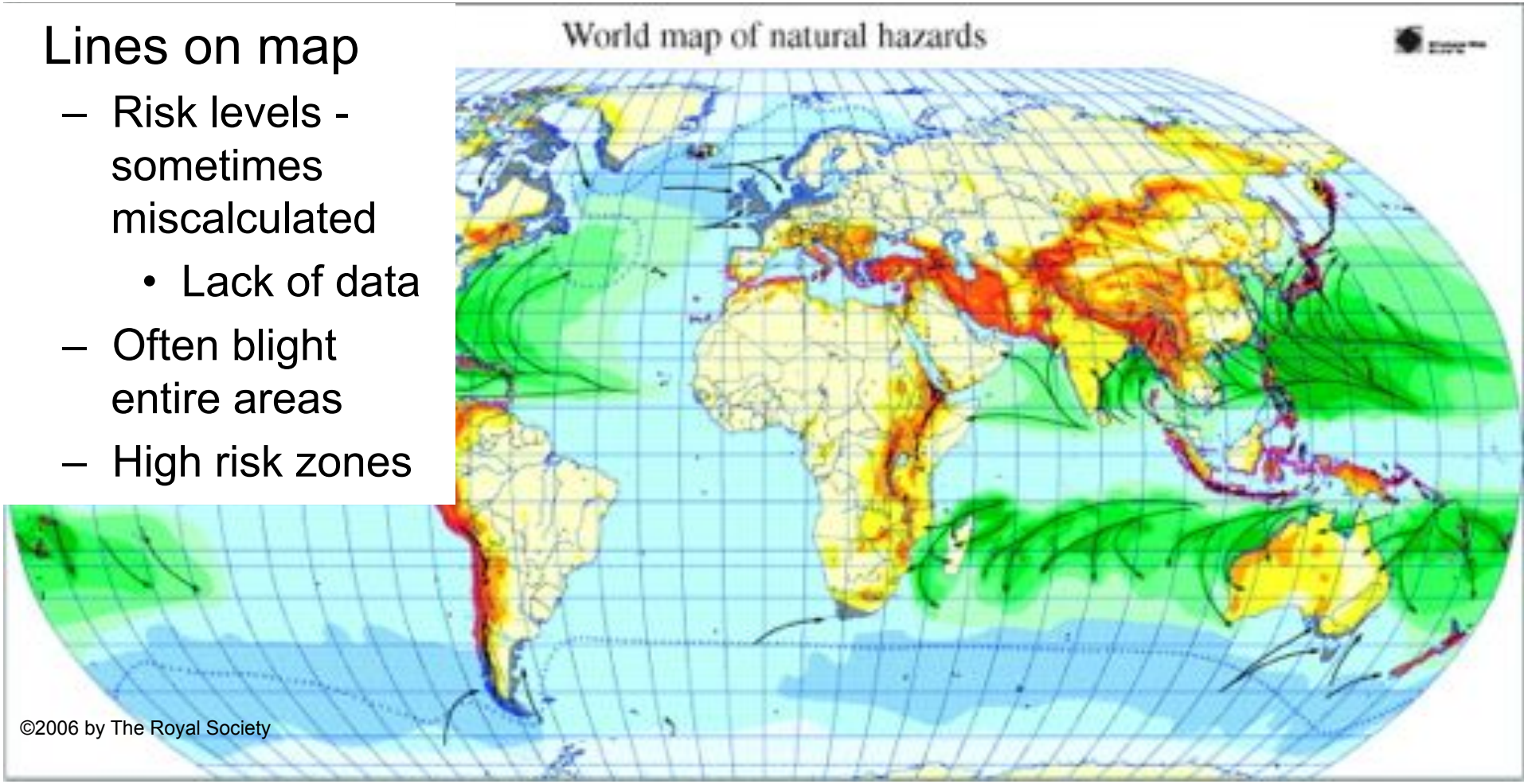
Communicating risk with maps

- Lines on map
  - Risk levels - sometimes miscalculated
    - Lack of data
  - Often blight entire areas
  - High risk zones



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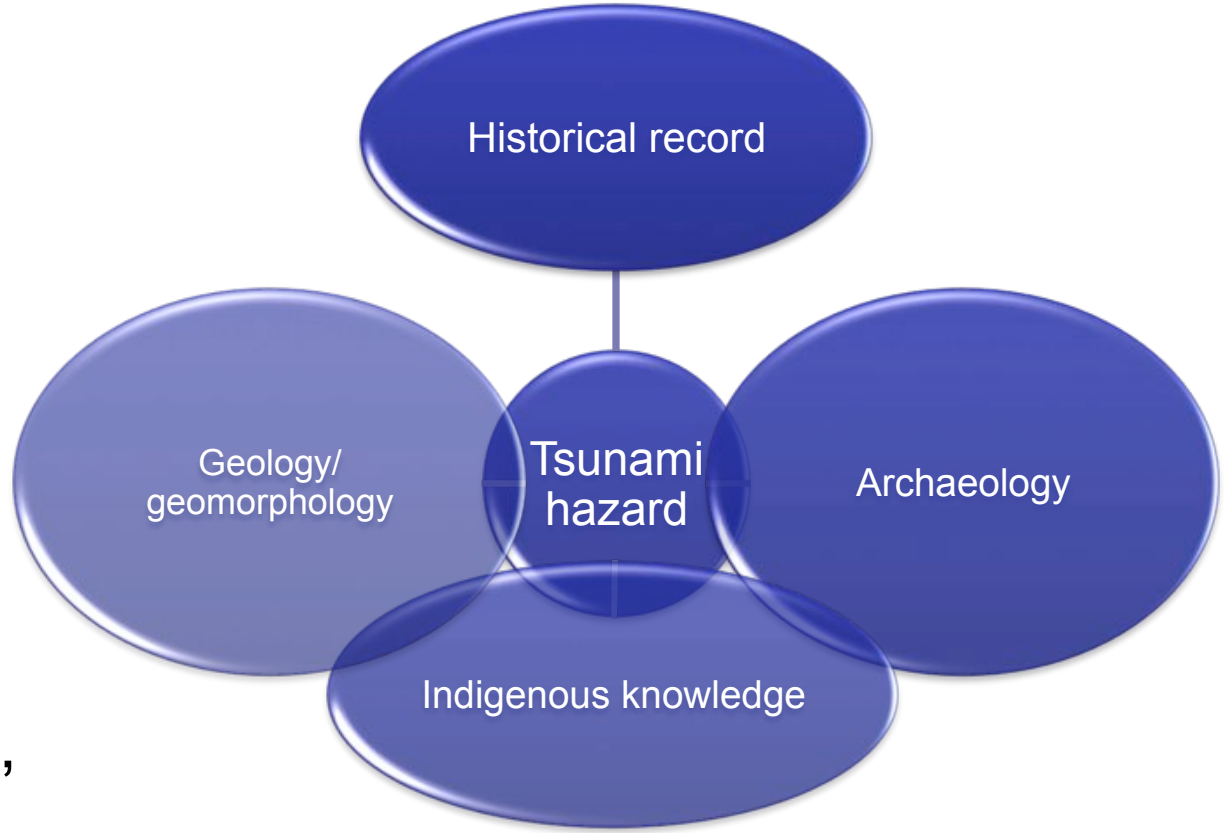
Tsunami in Taiwan - conclusions

- What are the most likely sources for tsunamis in Taiwan
- How do we prioritise sites of interest. Who cares?
- What information is already out there?
- Geomorphology / geology, archaeology, history, indegenous knowledge.



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