Infrequent Natural Hazards

Kenji SATAKE
Geological Survey of Japan

kenji.satake@aist.go.jp

Infrequent Hazard

1. Earthquakes, tsunamis or volcanic eruptions are rare compared to weather-related hazards.

2. Recurrence interval of giant earthquakes or super-eruption is 100’s to 1000’s years. Once they happen, the damage is significant.

3. For such infrequent events, historic and geological methods are used to study the past occurrence and effects.

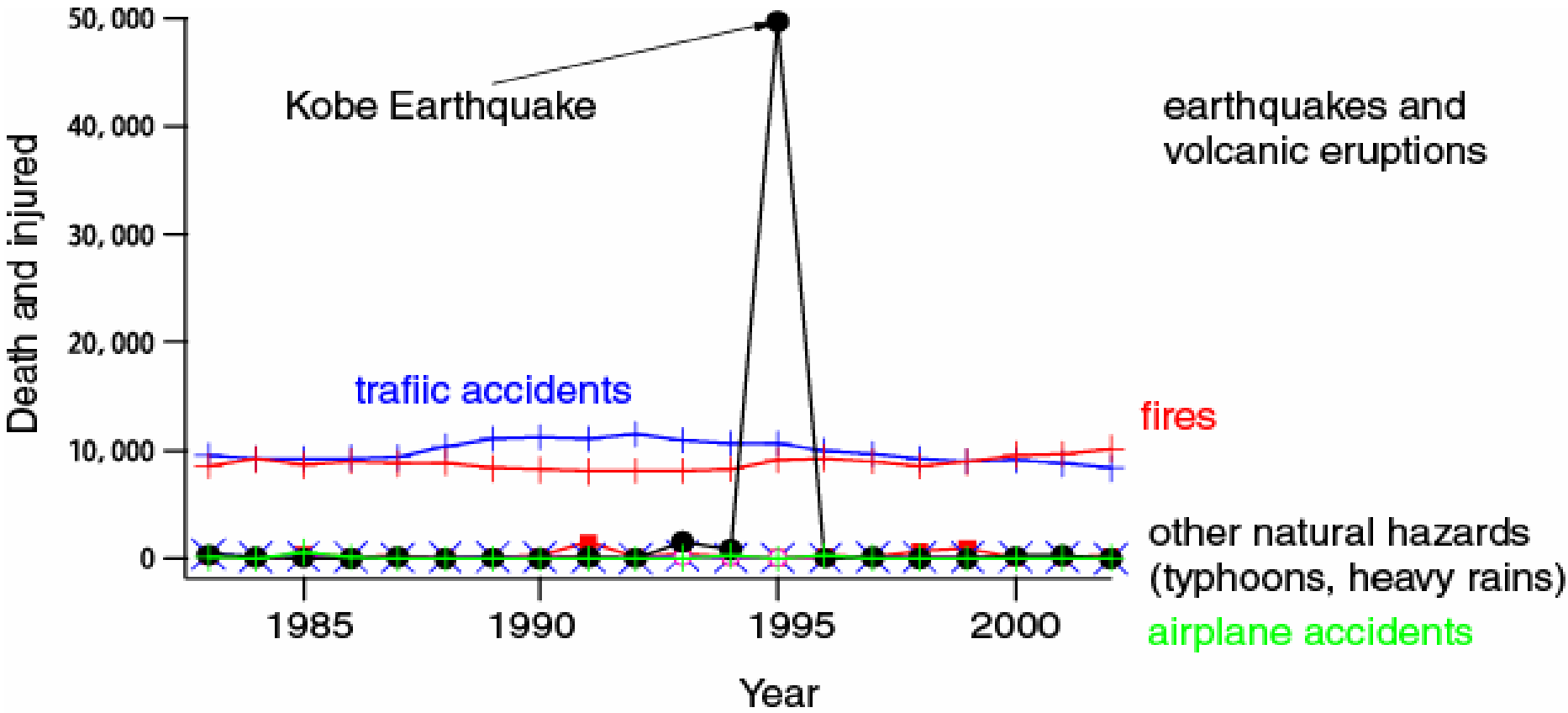
4. Probabilistic estimates, though the numbers are small, can be made based on past data.

Recent Damaging Earthquakes

1995	Kobe (Japan)	M 6.9	6,400 casualties
1999	Turkey	M 7.6	17,000 casualties
2001	Gujarat (India)	M 7.6	20,000 casualties
2003	Bam (Iran)	M 6.6	30,000 casualties
2004	Sumatra (Indonesia)	M 9.3	230,000 casualties
2005	Kashmir (Pakistan)	M 7.6	86,000 casualties

Many earthquake disasters in Asia
At each location, occurrence is infrequent (1 / 1000s years)

Affected People by Natural Hazards



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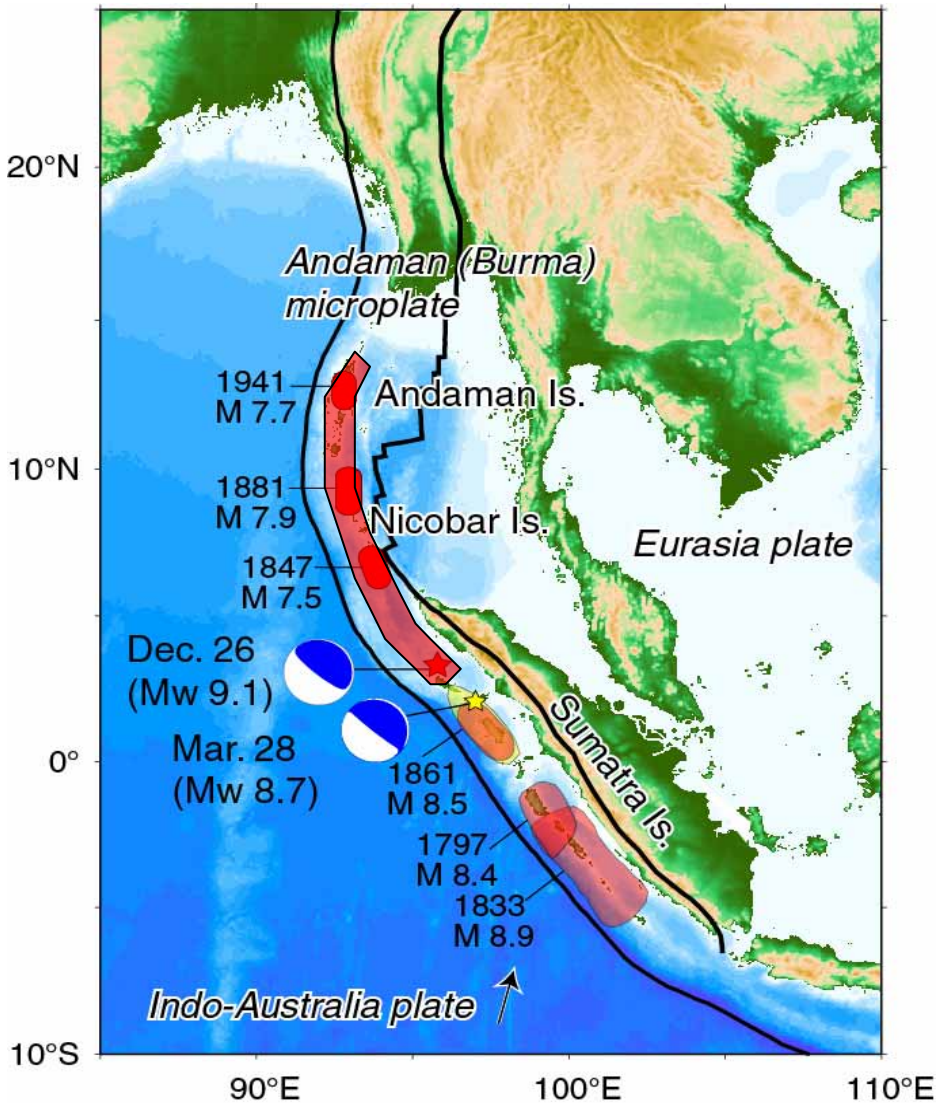
HERP

The 2004 Sumatra-Andaman Earthquake



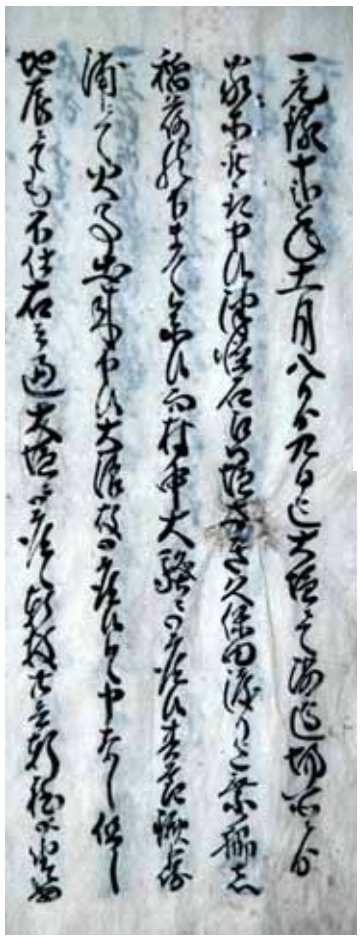
Andaman-Nicobar Is.
1941 M 7.7
1881 M 7.9
1847 M 7.5
(from historical records)

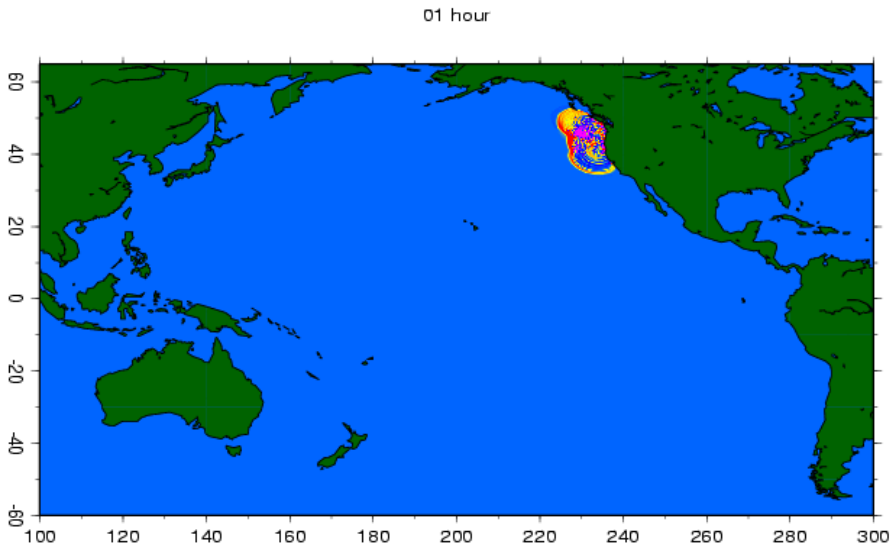
2004 M 9.1
2005 M 8.7

Sumatra
1861 M 8.5
1797 M 8.4
1833 M 8.9
(from coral studies)

1700 Cascadia earthquake (Mw~9)

Japanese documents





Jan. 26, 1700
around 9 pm
1100 km long
Mw~ 9

Satake et al. (1996, Nature)

Subsidence

Subsidence and tsunami

1896 Sanriku Tsunami

June 15, 1896
The worst tsunami disaster in Japan
~22,000 casualties

Tsunami breakwater: 10 m high, 2.4 km long

Mt. Pinatubo Eruption 1991

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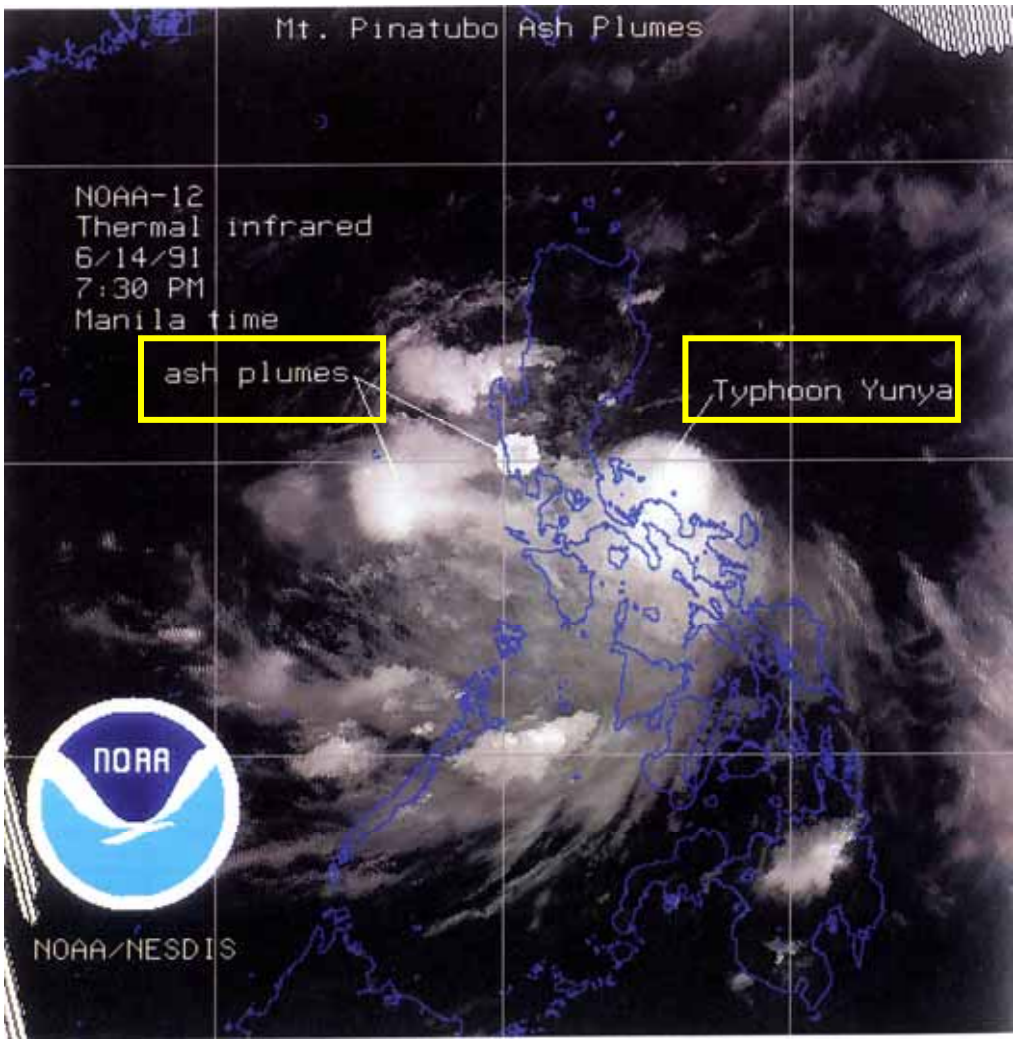


June 15, 1991
-climactic eruption coincident with
-Typhoon Yunya

Forecast saved thousands of lives

Hazards due to
-Ash deposit
-Pyroclastic deposit
-Lahar

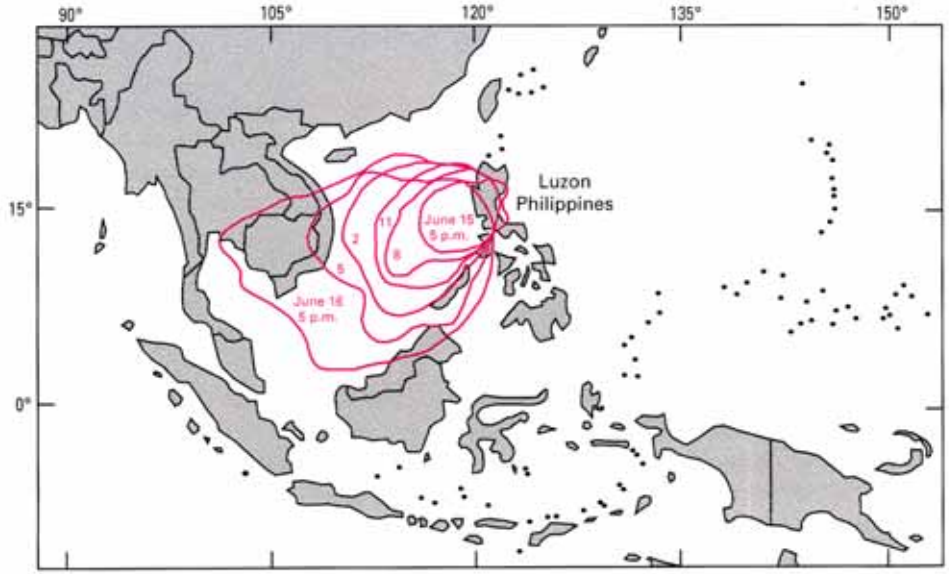
Mt. Pinatubo Eruption 1991

Bucao river
before eruption

Lahar deposit
~25 m thick

Punongbayan (1996)

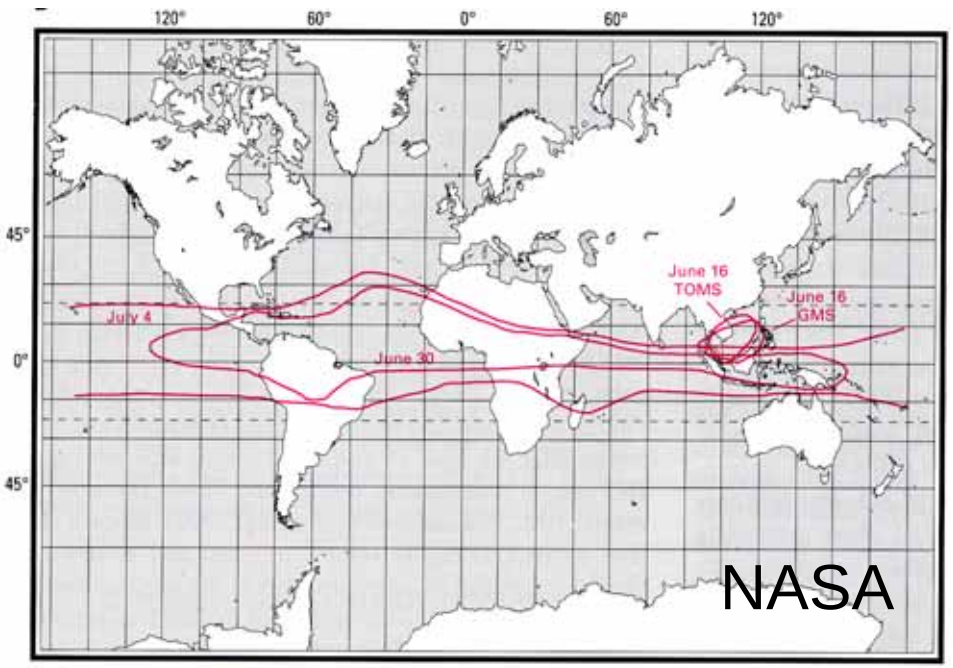
Mt. Pinatubo Eruption 1991

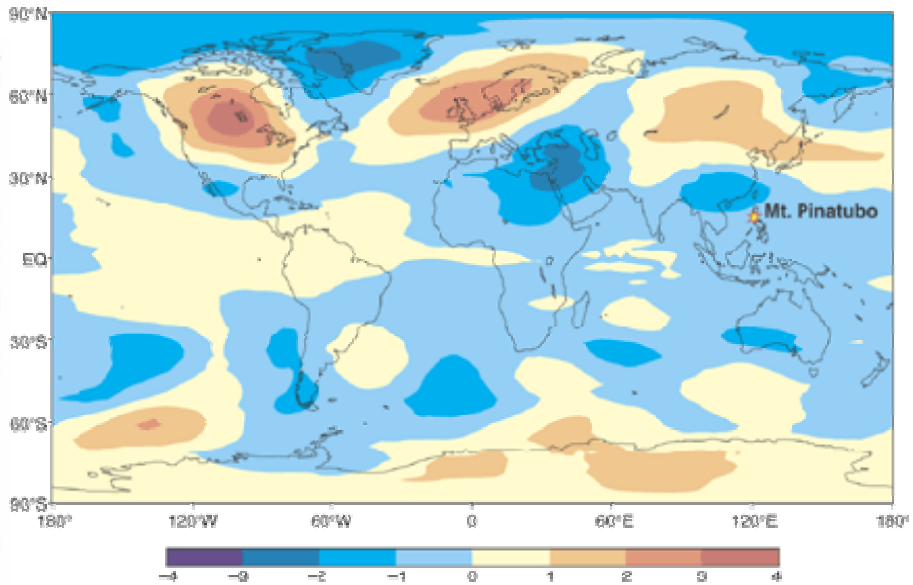


Global effects

Ash around the globe
Destruction of ozone layer

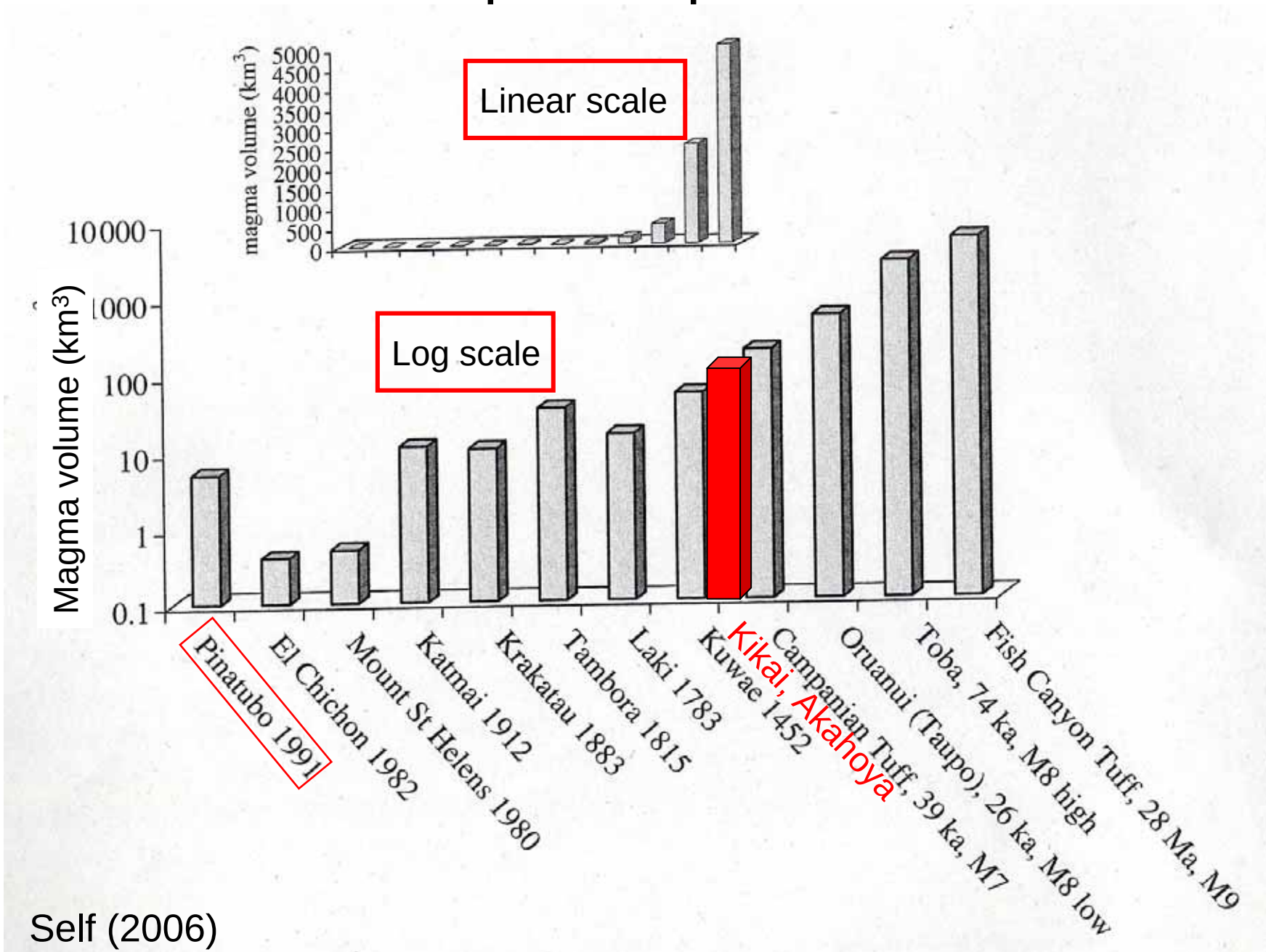
Northern Hemisphere
summer: temp drop up to 2ºC
winter: temp rise up to 3ºC





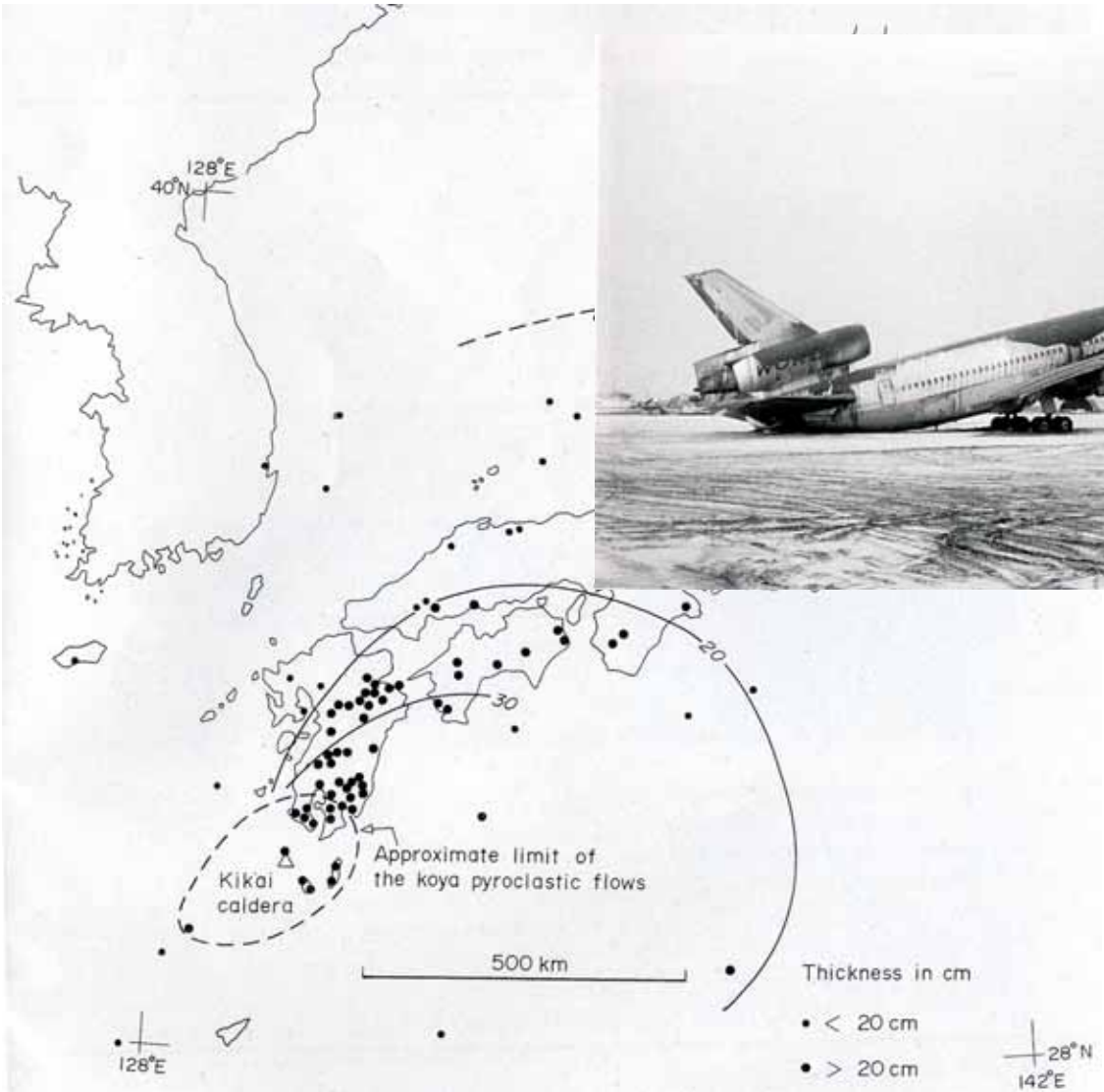
Robock (2002)

Super Eruptions



Self (2006)

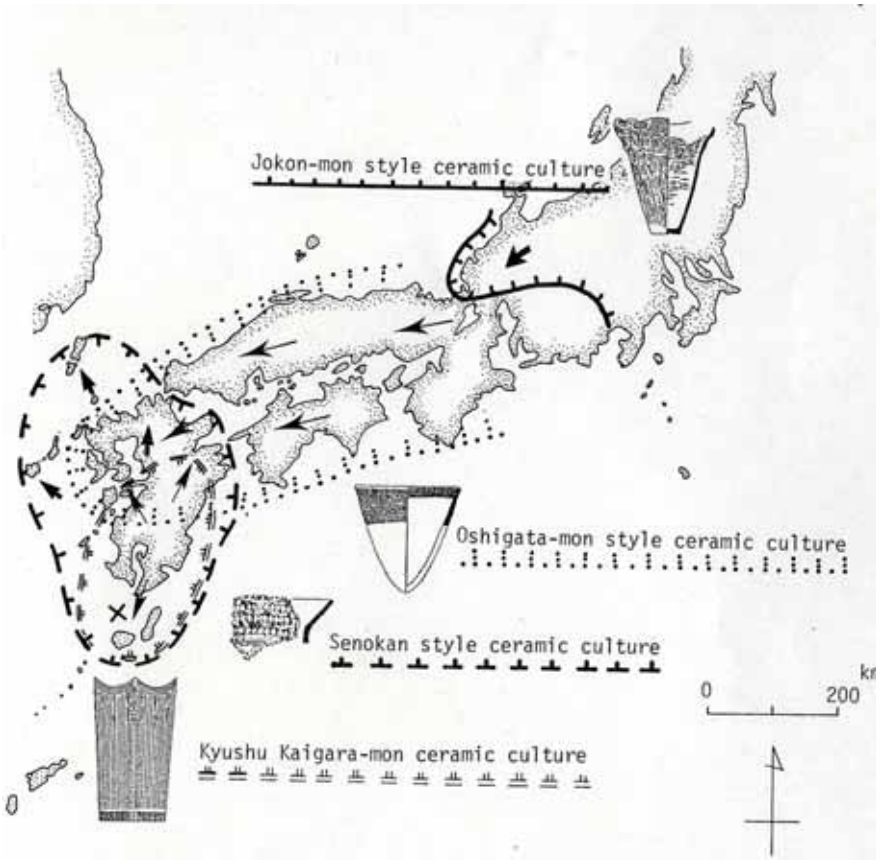
Kikai Akahoya eruption: 7,000 years ago



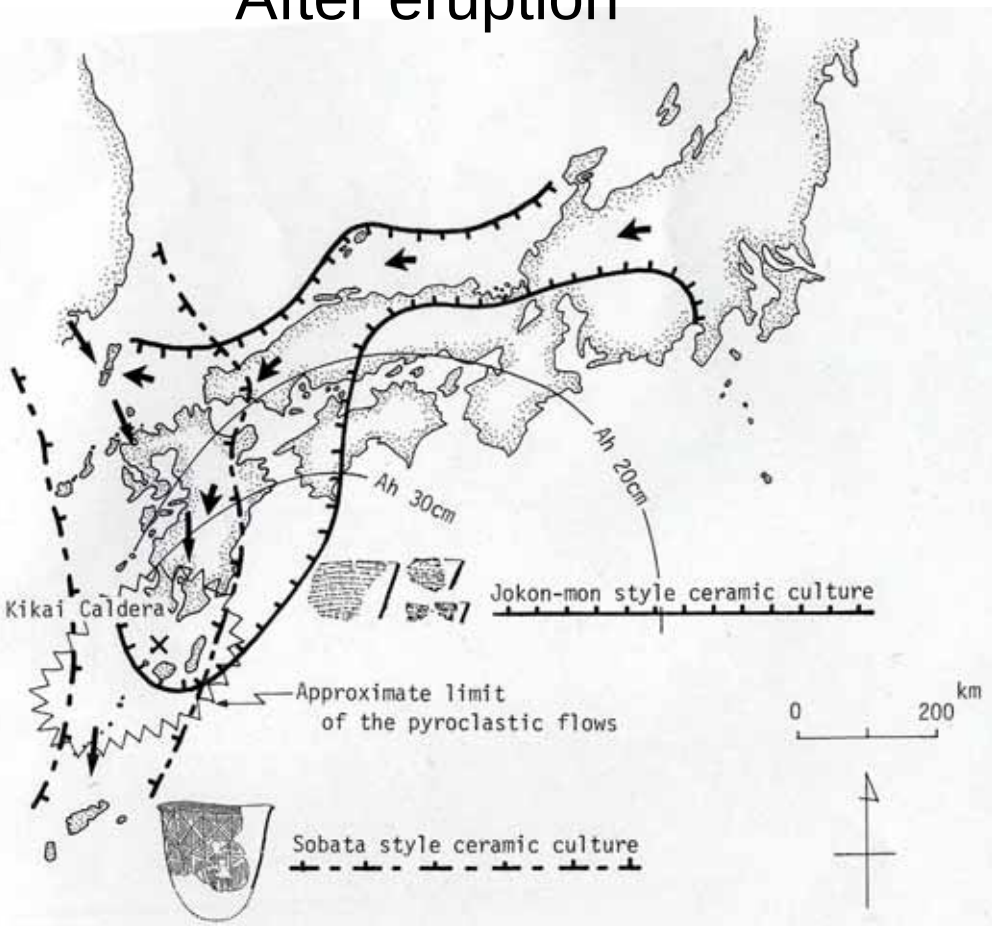
Machida (1984)

Akahoya eruption affected Jomon culture

Before eruption



After eruption



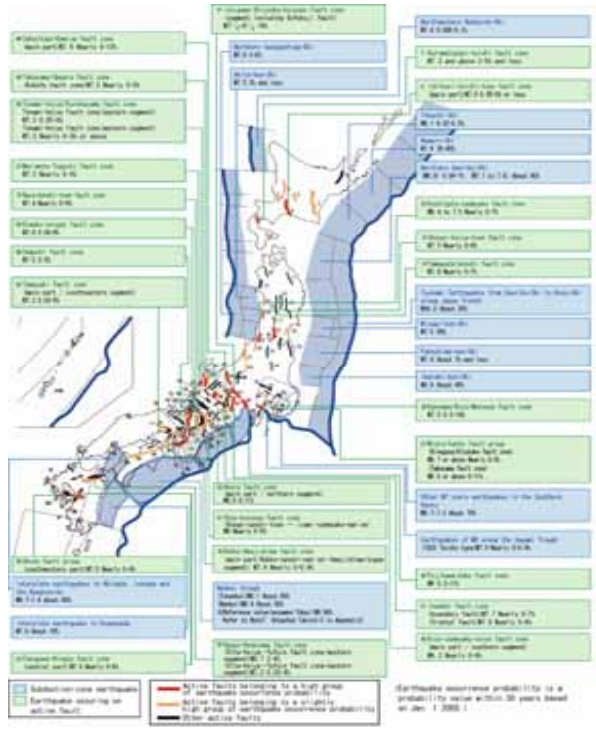
Machida (1984)

Long-term Forecast

Japanese Government announced

Probability in next 30 years

Miyagi-oki	99 %
Nankai Trough	50-60 %
ISTL (inland fault)	14%
most active faults	< 5%

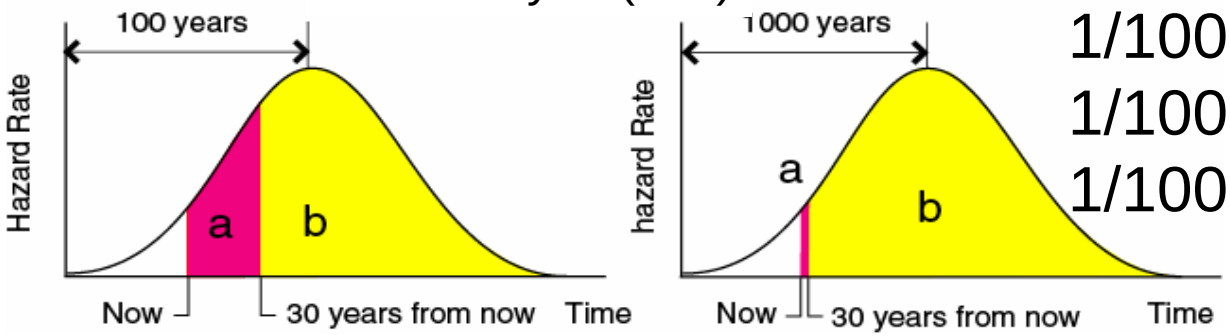


Probability of Kobe eq. in 1995

0.02-8 %

(if paleoseismological studies were made prior to 1995)

Probability=a/(a+b)



Max probability for 30 yrs

1/100 yr event	~ 90 %
1/1000 yr event	~ 20 %
1/10000 yr event	~ 2 %

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