CITY UNIVERSITY LONDON

Fukushima: some observations

Eleventh Bieleschweig Workshop, Bielefeld, 3-4 August 2011
The Fukushima Accident and Systems Prone to EUE

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Motivation

- This was not an accident that had not been conceived of, tsunamis and earthquakes are deeply embedded in the culture (and art) of Japan. So how did a society sensitised to the initiating events, technologically advanced with world class engineering resources have this accident and what can we learn from it?

- focus on issue of analysis of tsunami hazard

- (other issues on why 4 hrs for power back up, recovery when overall society affected, multiple reactor issues....)

"High dwellings are the peace and harmony of our descendants,"

Vincent Yu/Associated Press A centuries-old tablet warned of tsunamis in the town of Aneyoshi, Iwate Prefecture, in northern Japan.

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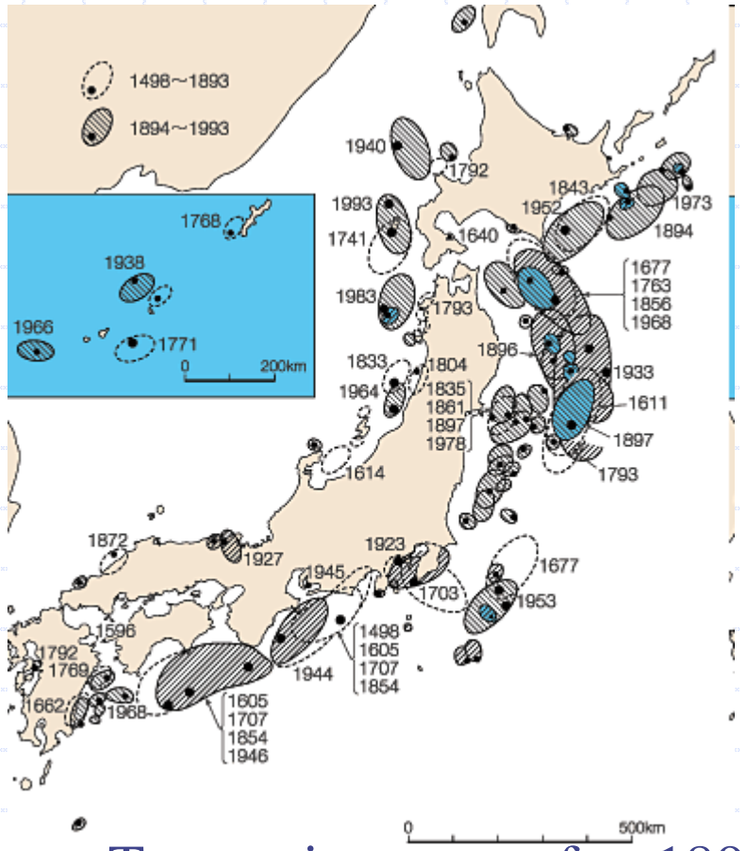
Nov. 2005

Tsunamis in Japan

- About 200 records
  - More than 1300-years history
- Recently
  - 1993 Hokkaido-Nansei-Oki
  - 1994 Kuril Islands
  - 2003 off Tokachi
  - 2004 0ff Kii Peninsula
  - 2005 0ff Sanriku
  - 2010 Chile (far-field)



Tsunami sources after 1890

Learning from Fukushima

- there might be a danger of only focusing on the specific accident that happened at Fukushima.
  - do not have BWRs in the UK, tsunamis are possible but rare.
  - must analyse the specific problems at Fukushima (and the successes elsewhere) for lessons relevant .
- it is not the *specific* accident but rather
  - that there might have been a failure of regulation and safety analysis that did not address a credible event adequately.
  - might also be an international, institutional, failure that this issue was not vigorously addressed by, say, the IAEA.
- to what extent are we vulnerable to such a failure, what might be the "blind" spot in our own assessments?
  - socio-technical-political perspective required

Source for following slides:

Aim of Session B : Tsunami

Fumihiko Imamura

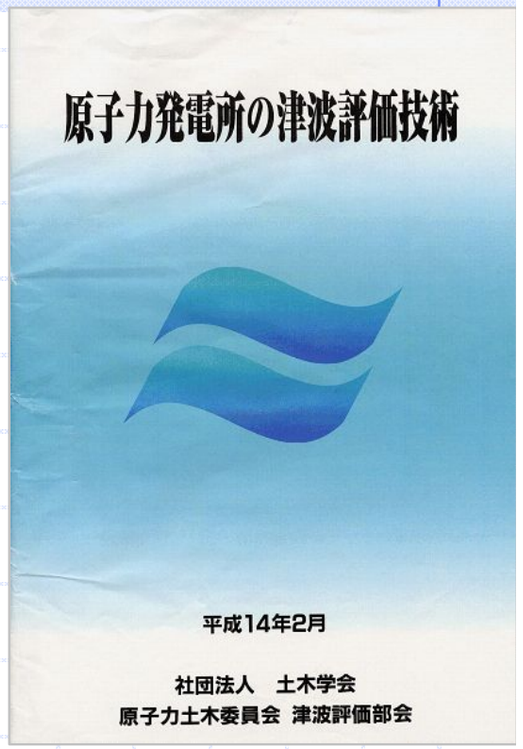
Session Coordinator
Tohoku University

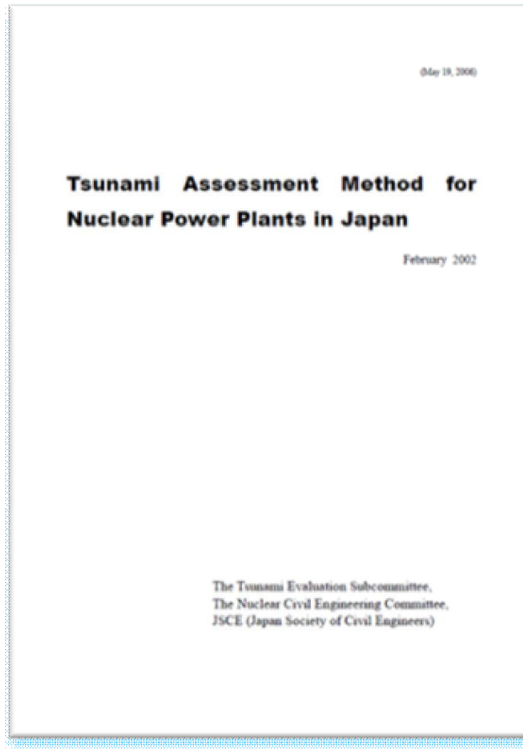
Tsunami manual 2002

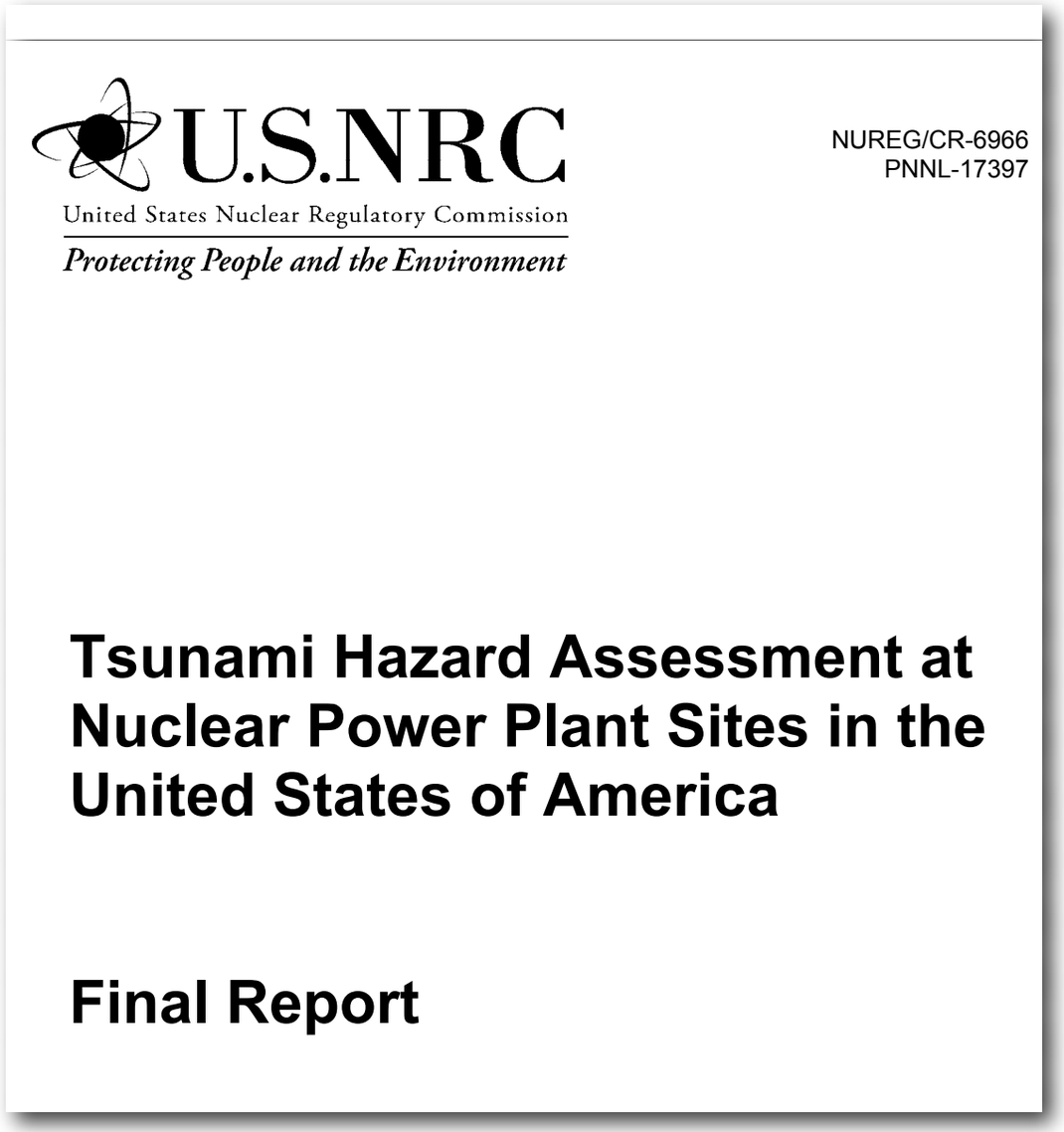
- “Tsunami assessment method for NPP in Japan」（2002）”
- English version Has been made public in 2006.

- Assessment viewpoints
  - The maximum and minimum water levels by deterministic method
  - Parametric study in terms of fault parameters

- http://www.jsce.or.jp/committee/ceofnp/Tsunami/eng/tsunami_eng.html







- Tsunami-hazard assessment is a necessity for nuclear power plant sites in Japan. Consequently, Japanese tsunami-hazard-assessment approaches are some of the most advanced in the world. The assessment method for the tsunami hazard at Japanese nuclear power plants is described by the Japanese Society of Civil Engineers (JSCE) (2002).

- The design tsunami is defined as one that causes the maximum water rise or fall at the nuclear power plant site. The design water level is defined as the sum of water level caused by the design tsunami in combination with an appropriate tidal condition.

- Even though Japan has the most extensive historical database of tsunamigenic earthquakes, significant uncertainty in source parameters exist. To account for this uncertainty, JSCE requires a parametric study, ... The tsunami or tsunamis that cause the maximum water rise or fall at the site are selected as design tsunamis.

- Design tsunamis are verified by comparing .. water levels corresponding to all recorded and numerically simulated historical tsunamis at the site. Additionally, the envelope of scenario tsunami- water levels in the vicinity of the site should exceed all recorded or simulated historical tsunami-water levels.

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- **PROBABLE MAXIMUM TSUNAMI**

- The PMT is not estimated using a probabilistic approach. It is, on the contrary, a deterministic approach that incorporates ideas of transposition and maximization,.... (weather forecasting..)

Revisited after Chilean tsunami feb 2010-nov 2010?

Tsunami Assessment for Nuclear Power Plants in Japan.

Makoto TAKAO, PE

東京電力 TEPCO

TOKYO ELECTRIC POWER COMPANY

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- ✓ We assessed and confirmed the safety of the nuclear power plants based on the JSCE method which was published in 2002.

- ✓ On Feb. 28, in response to the “Tsunami warning” issued by the Japan Meteorological Agency, appropriate measures in accordance with "Accident Operating Procedures (AOP) " were executed.

- ✓ Daily operations were NOT impacted.

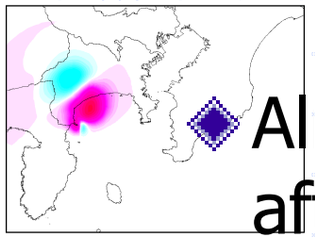
東京電力

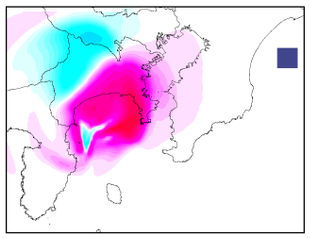
Tsunami Assessment method for NPP in JSCE, Japan

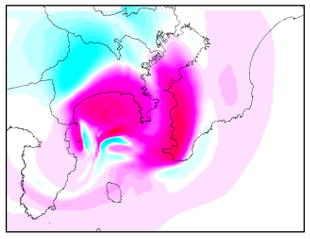
The TSUNAMI EVALUATION SUBCOMMITTEE,
Nuclear Civil Engineering Committee, JSCE

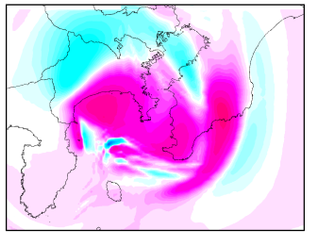
Masafumi Matsuyama (CRIEPI)

A brief review of recent activities

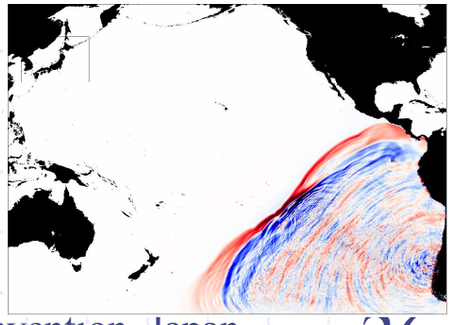








- Almost ten years have passed after tsunami manual released.
- Recent advances and new knowledge
  - Tsunami source model (fault model)
    - Re-evaluation of historical tsunami faults
    - Spatial inhomogeneity in terms of slip
  - Numerical simulation
    - New simulation method of crustal motion (GMS, Grand Motion Simulator by NIED*)
    - New simulation method of far field tsunami
      - Nonlinear dispersion theory



*National Research Institute for Earth Science and Disaster Prevention, Japan

Tsunami assessment method in JSCE

- Assessment viewpoints
  - main
    - The maximum and minimum water levels
    - Deterministic method
    - + Probabilistic, near future
  - additional (according to need)
    - Topography change affect to ECCS
    - Fluid force to NPP facilities

New “Tsunami assessment method for NPP in Japan”
At 2012

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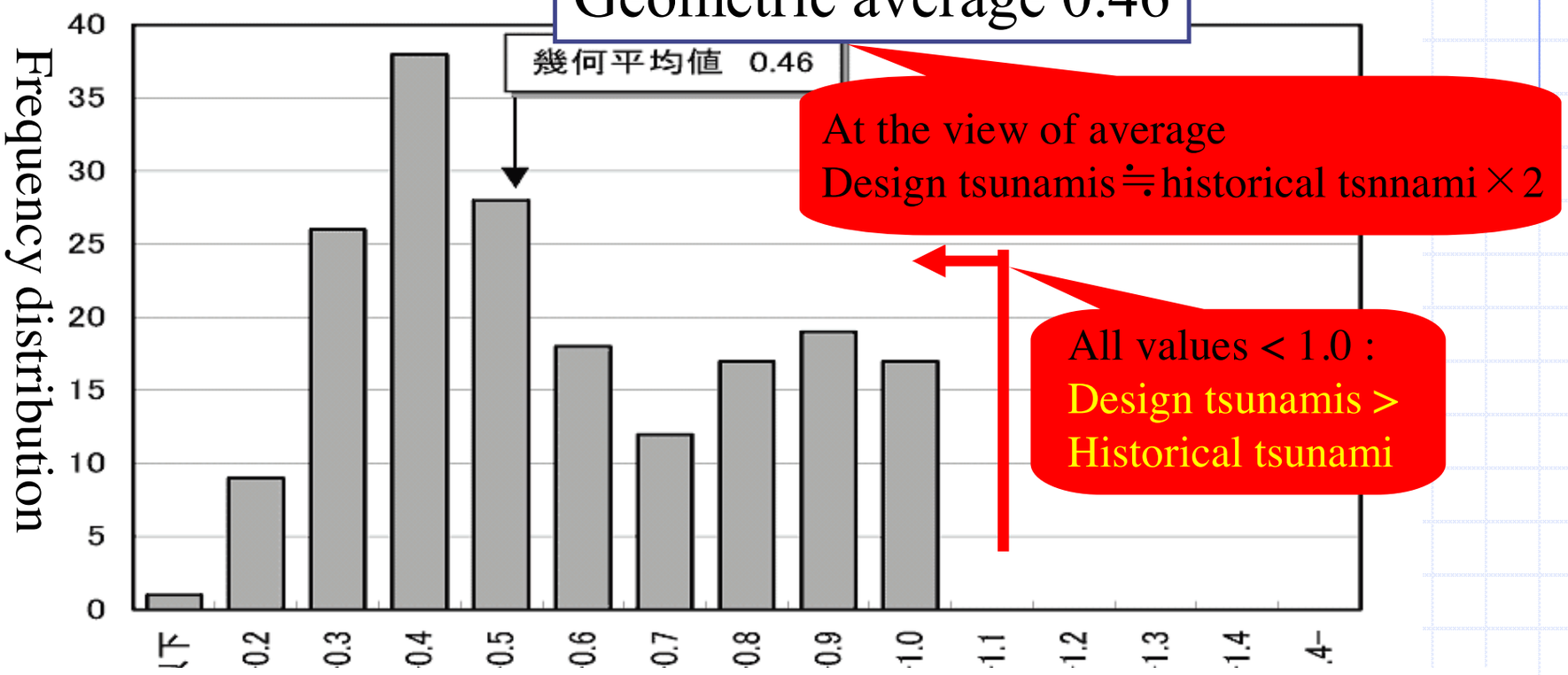
Validity of parametric study

Nov. 2005

Geometric average 0.46



Mes.／calc. by basis tsunamis (as a result of parametric study)

We check 185 heights by historical tsunami along coast.
But they don't include all heights in Japan.

Key issues

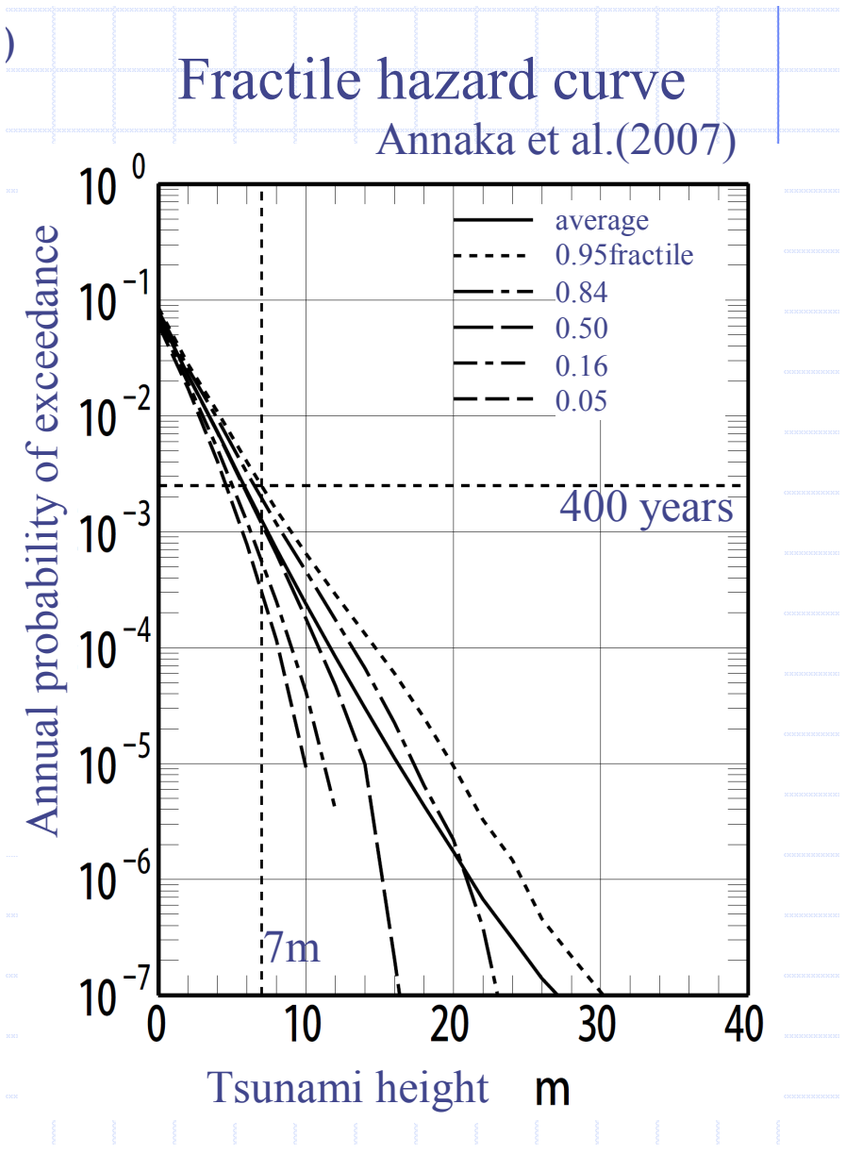
Classification of uncertainties

- Aleatory uncertainty
  - Random nature of earthquake occurrence and its effects :position, time and so on of earthquake occurrence
- Epistemic uncertainty
  - incomplete knowledge and data about the earthquake process : various model parameters and various alternatives

Speculation

- Speculation (on basis of this superficial analysis)
  - initial deterministic assessment too limited? sensitivity studies?
    - very non-linear with tsunami height, strong threshold effects
    - complex systems and power laws, how dealt with fat tails
    - how to deal with aleatory and epistemic uncertainties and how this impacts communication
      - aleatory once “in a 1000 years confused” with “not until 1000 years”
      - numbers travel social distances but not their caveats
    - if hazard analysis wrong, don’t blame the pilot - sympton not cause
    - or was it one of those rare events that happens..
  - learning from experience?
    - some evidence of erosion of safety?
    - tempo (organisational impact?) to revisit and update?
    - what did the revised methodology say about Fukushima?
    - international institution role? intervention? critical enough?

Probability of exceedance



In progress ...

- Tsunami hazard not a surprise
  - guidance 2002
  - assessment revisited in 2010,awareness among specialists of need to revise this
  - not sure what the results of re-evaluation (if any) but considerable work on method, publication was due in 2012 Introductory, superficial talk.
- So how did a society sensitised to the initiating events, technologically advanced with world class engineering resources have this accident and what can we learn from it?
  - Need more rigorous analysis, but evidence lacking
  - Key issue is dealing with uncertainty in analysis and communication

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