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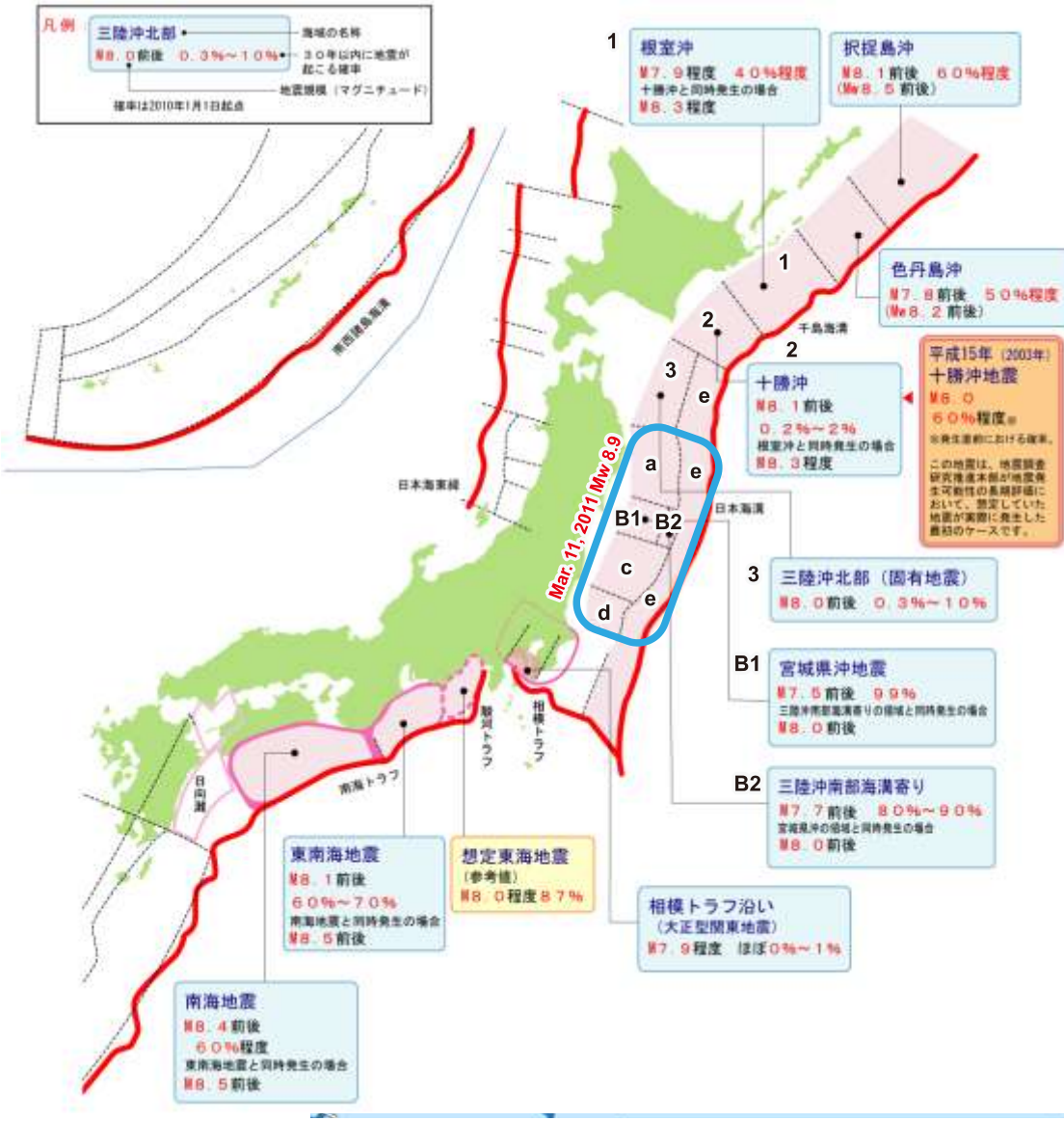
The precautionary principle: Natural hazards and critical infrastructure

Acknowledge
EEFIT Team: Antonios Pomonis, Keiko Saito, Stuart Fraser, Siau Chen Chian, Katsu Goda, Joshua Macabuag, Mark Offord, Alison Raby

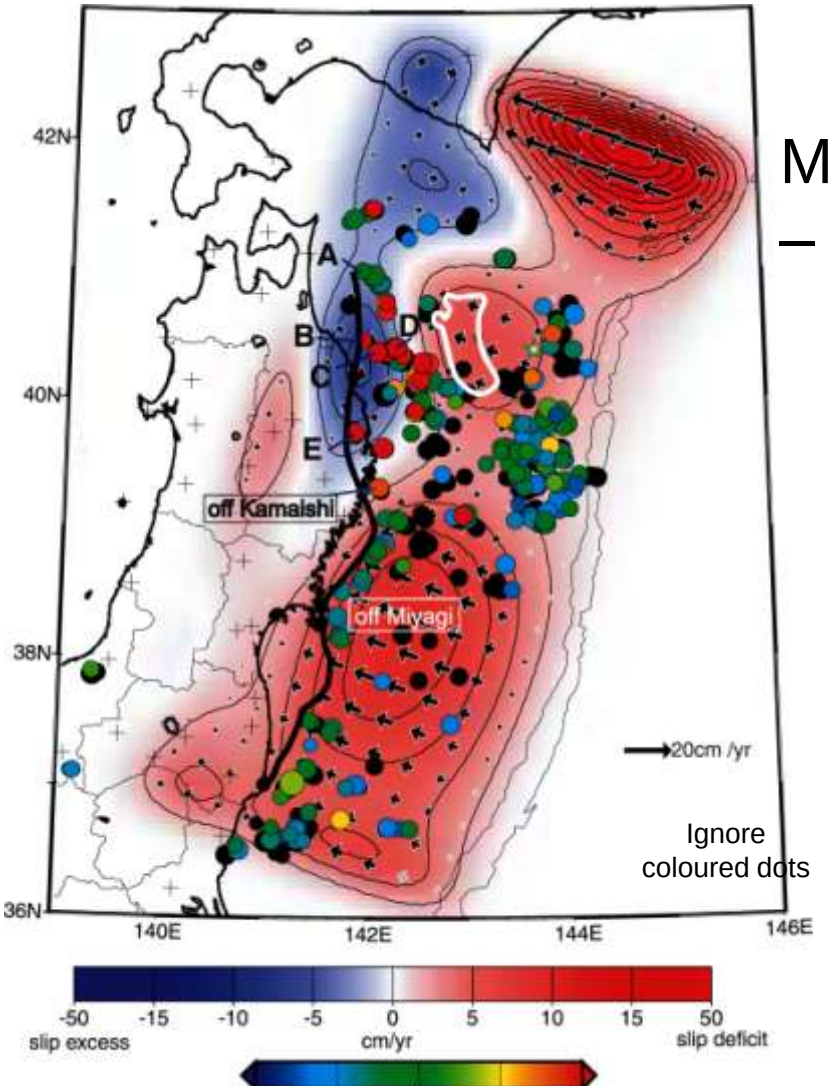
Was the 11th March 2011 Tohoku earthquake forecast?

- Earthquakes expected in the source region had much smaller magnitude M 7.4 to 8.2
- From 6 smaller fault segments based on historical seismicity
- The March 11 earthquake ruptured all 6 segments in a single earthquake.

HERP: Headquarters for Earthquake Research Promotion (2009) map of fault segments along the Japan subduction zones with the 11th March Great East Japan Earthquake marked.



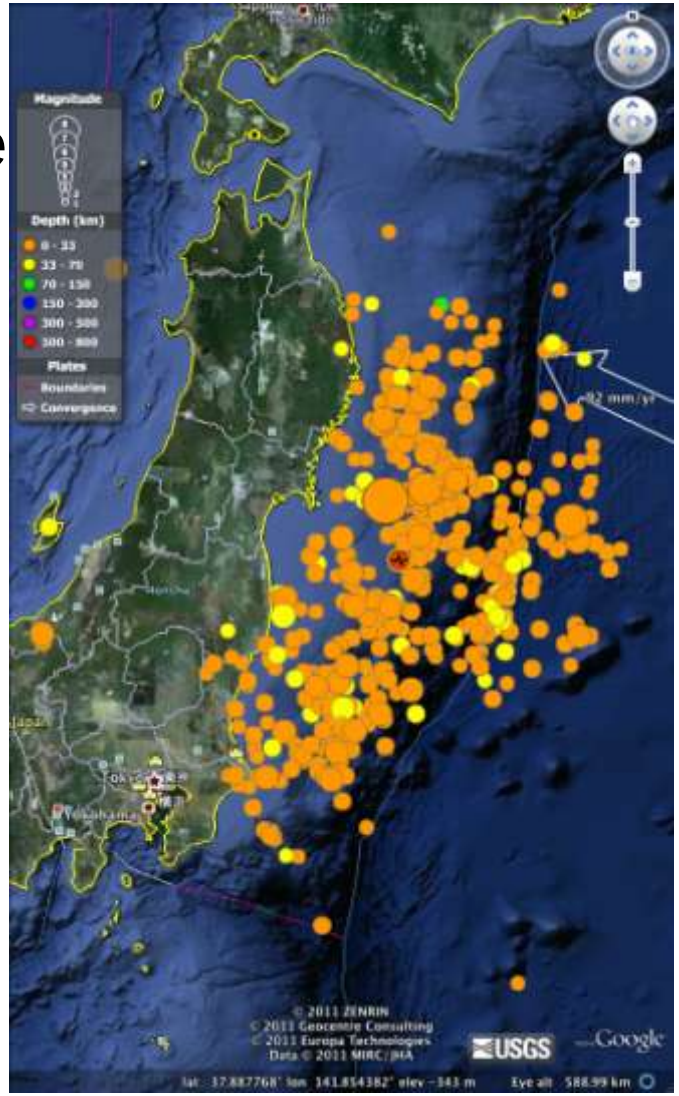
Could the Tohoku earthquake be forecast?



Ignore coloured dots

Slip-deficit from modelled GPS (Igarashi 2003 JGR).
Similar to the slip patch last Friday?

Magnitude – yes!



Earthquakes aftershocks

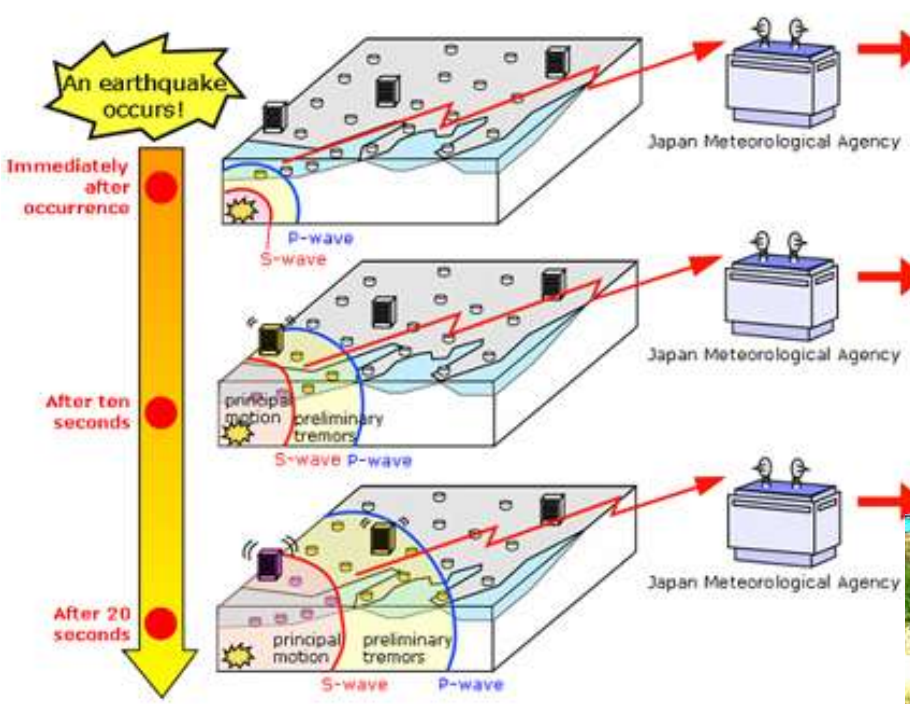
- Design tsunami height was 5.4 to 5.7 m
- Elevation of the plant was set higher
- Fukushima Daiichi NPS is 10 m to 13
- Tsunami on 11th March 2011 was 14 to 15 m high
- It struck the sea defences and overwhelmed the sea protection walls of the plant

Fukushima Daiichi site (TEPCO)

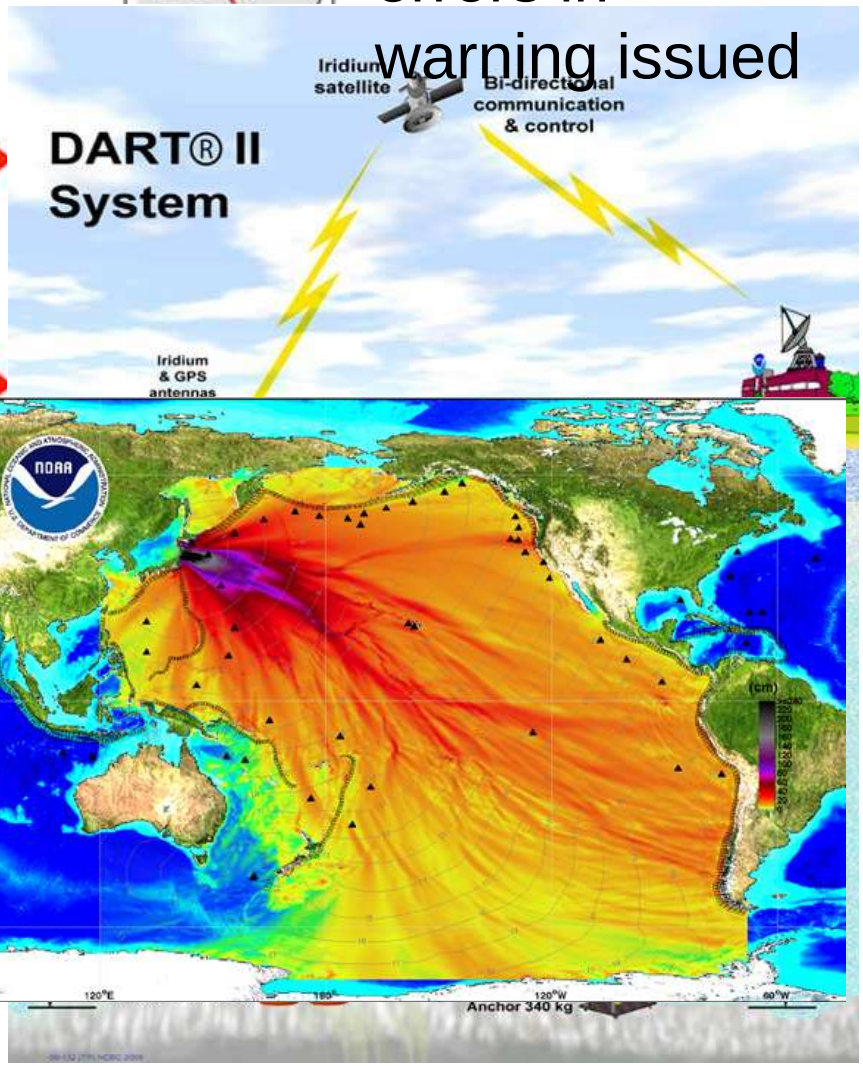
Was the 11th March 2011 Tohoku tsunami forecast?

Arahama Beach, Sendai

Did the warning systems and response work?



Significant errors in warning issued



- Estimated deaths for Tohoku earthquake ~8000 before 2011
- But army response was flexible within existing plan
- Warnings and evacuations did fail in part
- But excellent education and preparation saved 10,000 lives

Interrogating the Precautionary Principle

Precautionary Principle in Maastrict Treaty and Rio Declaration of Principles

Economic analysis of uncertainty: Expected Value versus Expected Utility (David Pearce)

Is this the Big One?

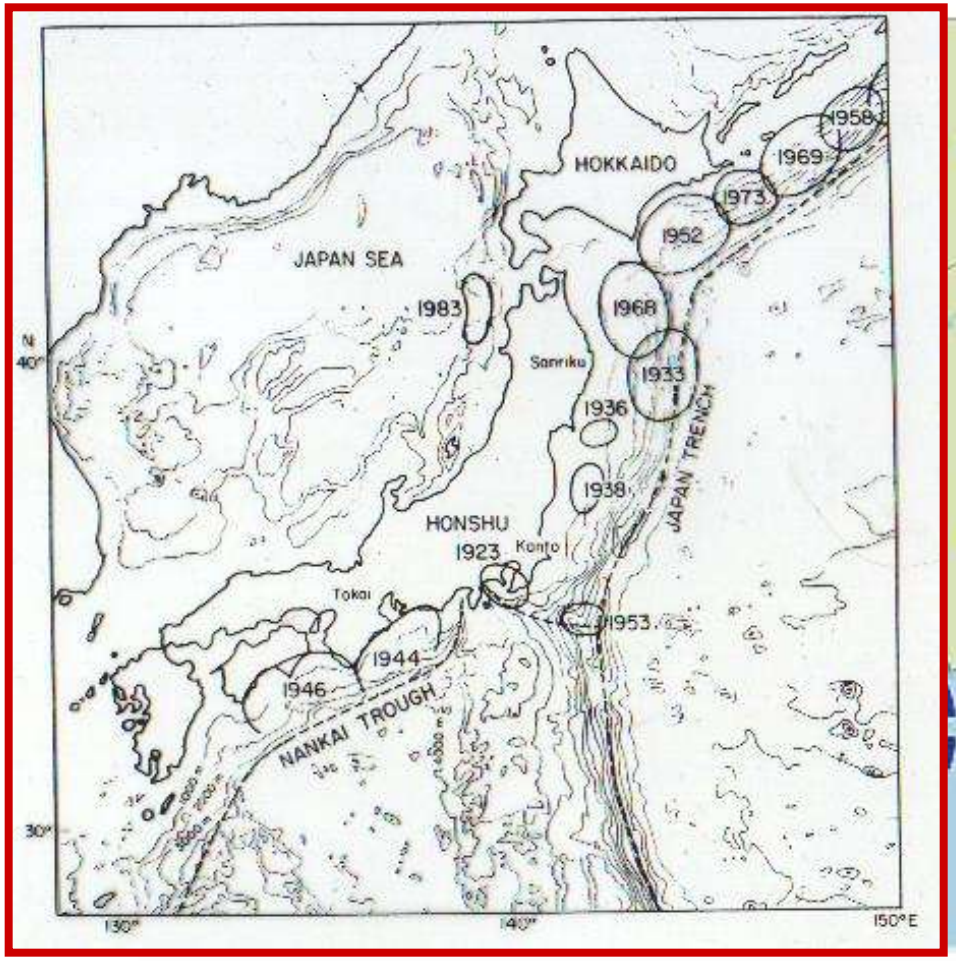


図 3　関東地震の震度分布および本震と余震の震源
本震の双子地震は小田原直下（第 1 イベント）と三浦半島直下（第 2 イベント）で発生した。本震直後の 2 回の余震は東京湾北部と山梨県東部が震源となった。断層面は長さ 130km にも及ぶ巨大なもので，震度 7 の激震域が広範囲にわたった。兵庫県南部地震の激震域と比べると，面積にして 10 倍以上となる。

Great Kanto Earthquake 1923

No

JMA Intensities

Great Kanto Earthquake 1923

- Great Kanto earthquake (Mw = 7.9; M_s = 8.2)
- Occurred along the Sagami Trough in the Sagami Bay on 1 September 1923
- One of the most disastrous earthquakes in Japanese history

Refugees – Imperial Palace

Saiten Tamura

- Earthquake claimed 99,331 dead, 43,746 missing, and left 3.4 million homeless
- Major social consequences - systematic massacres & political assassinations