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The Tohoku Earthquake and its Implications for the US

International Insurance Society
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Toronto, 22 Jun 2011

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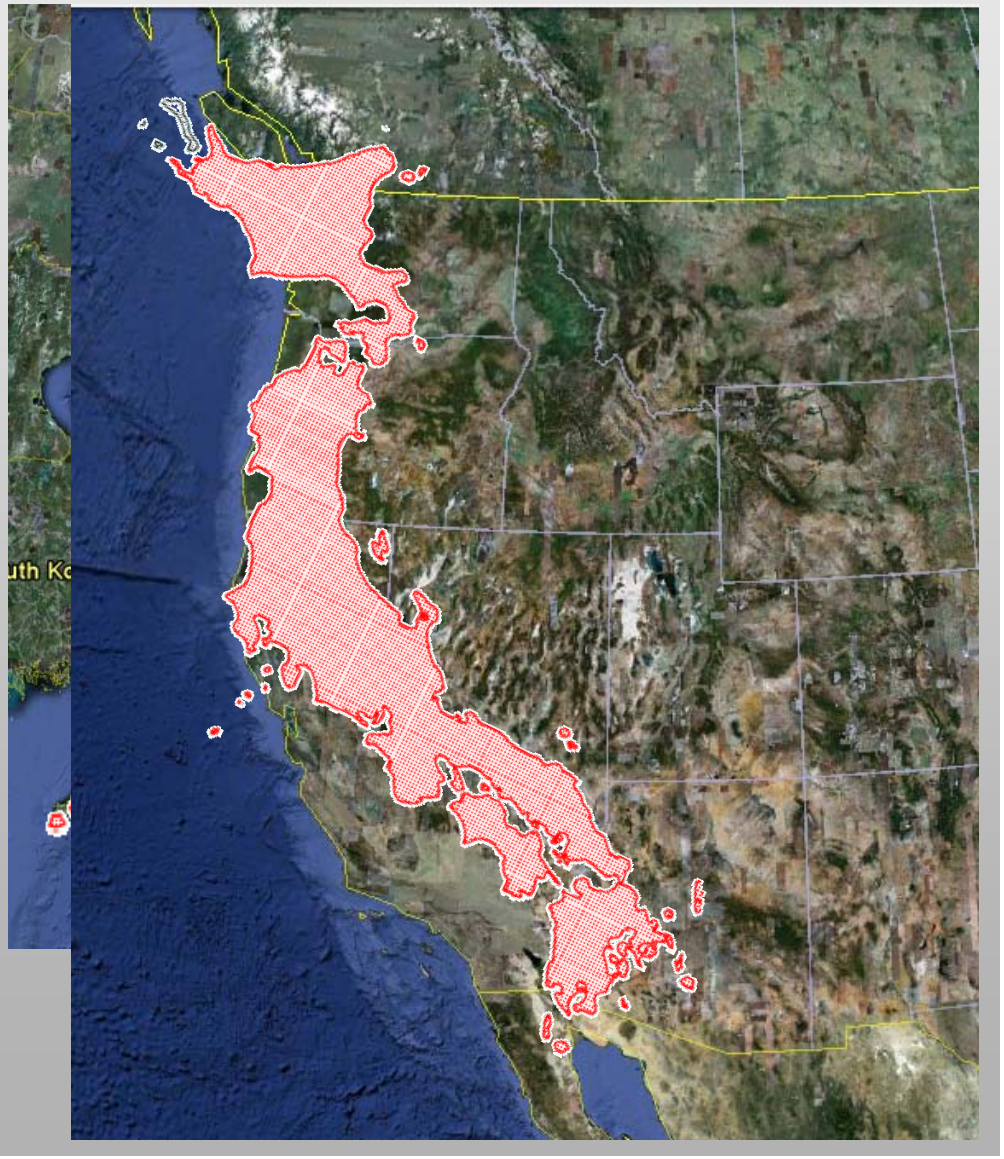
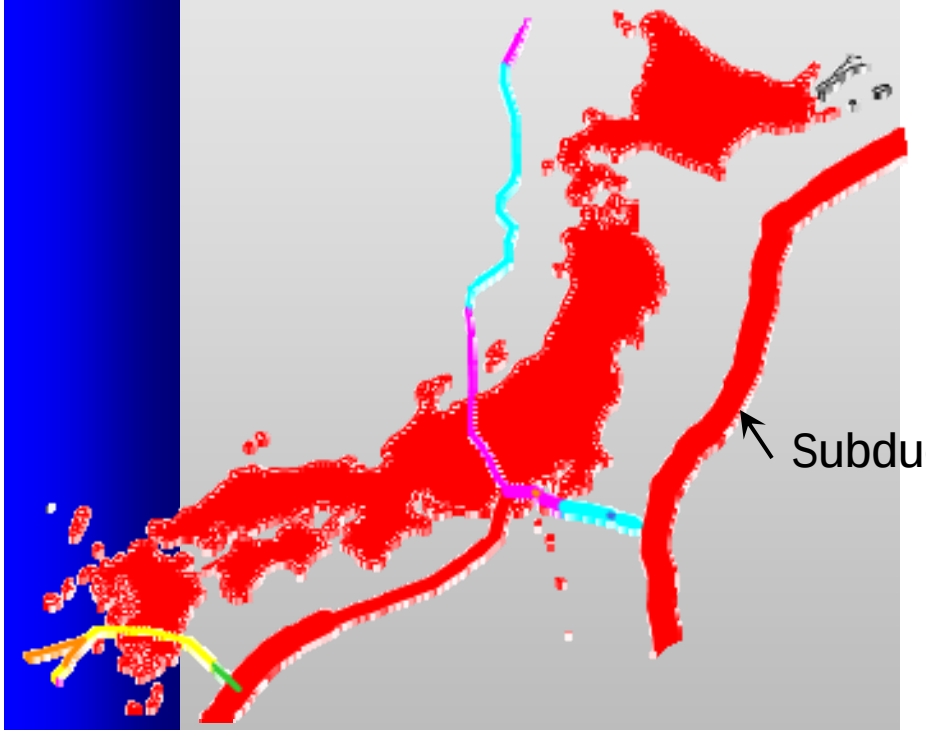
SPA Risk LLC

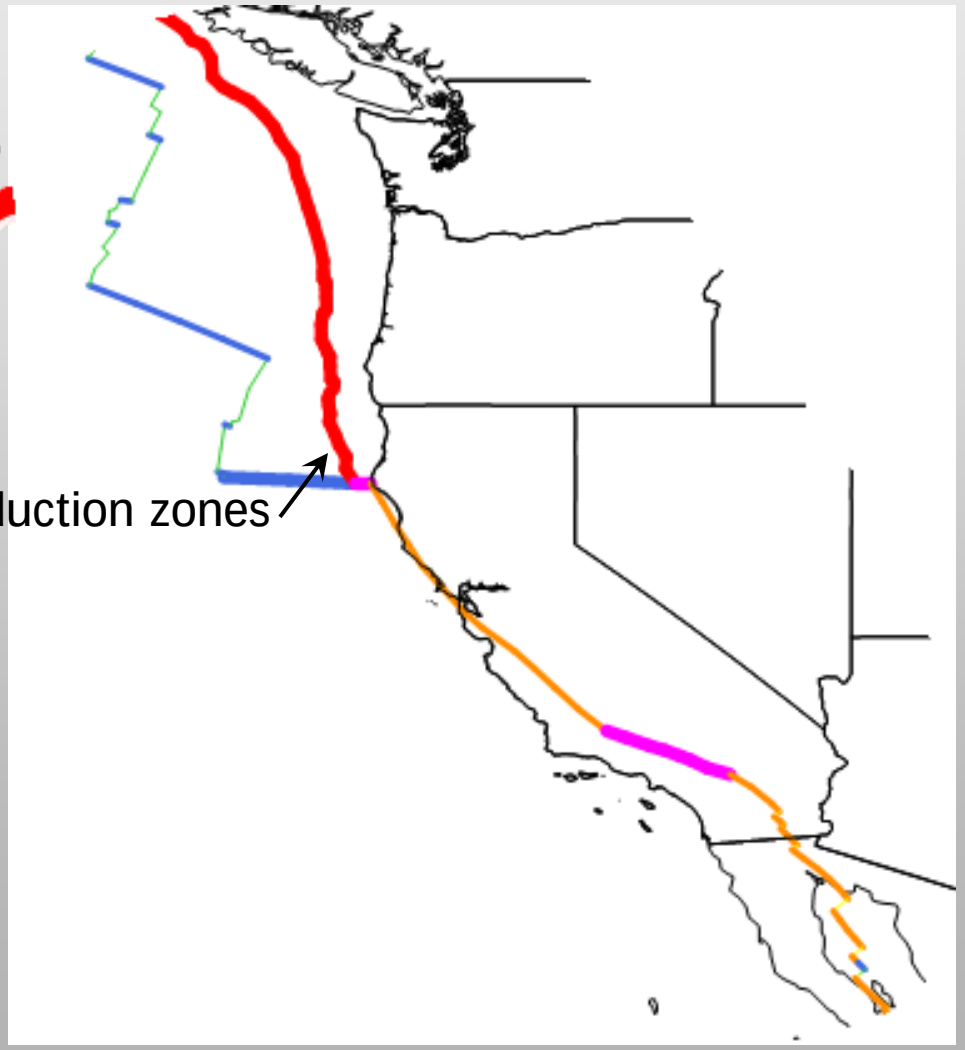
Outline

- Tohoku earthquake
  - Seismic setting
  - Tsunami & shaking
  - Building & lifeline damage
- USGS Tsunami Scenario



Similar seismic setting



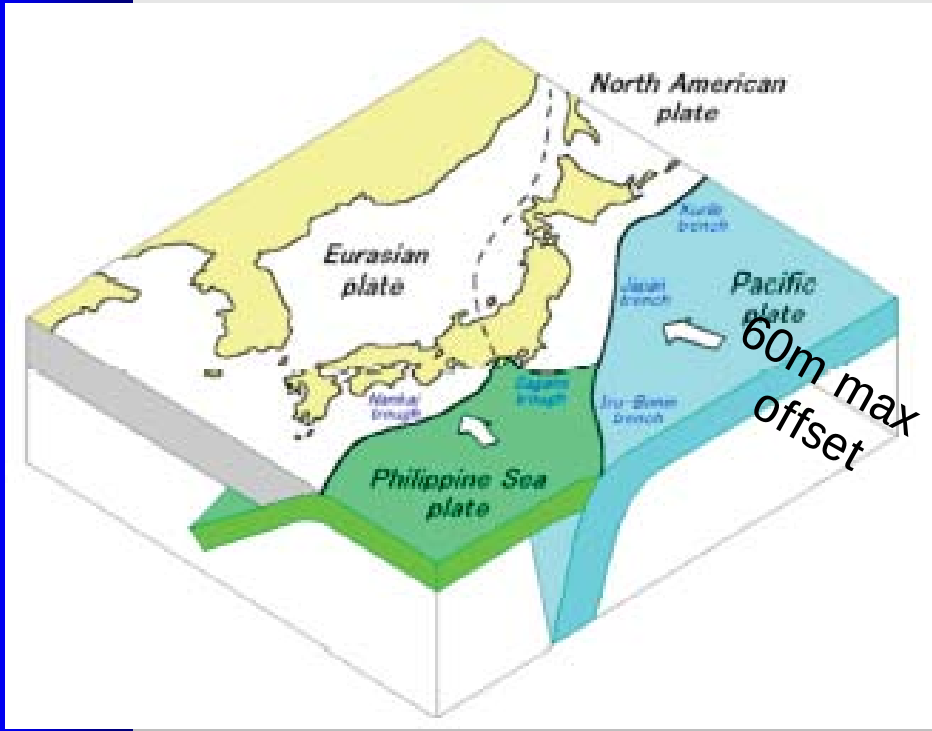


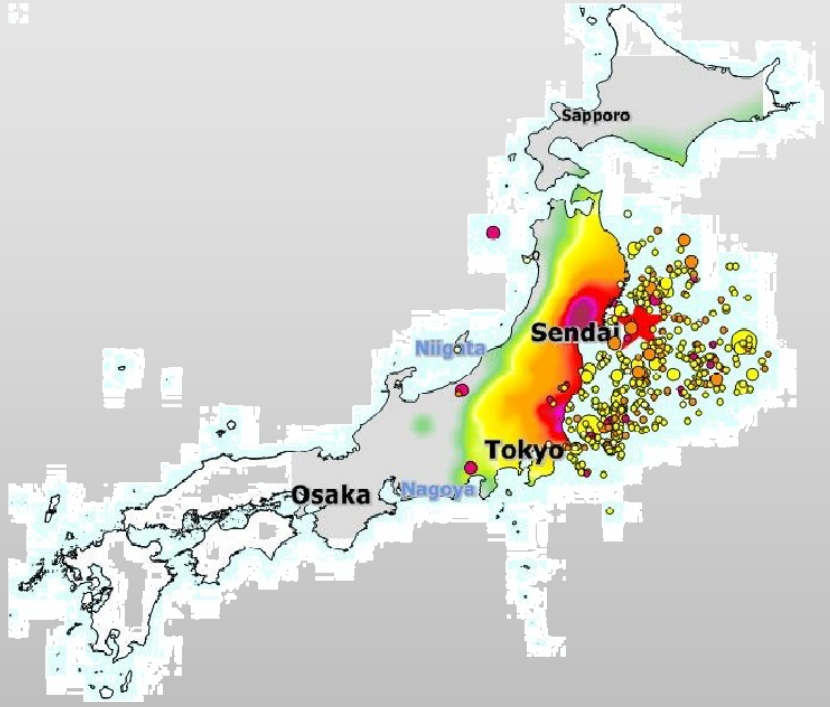
Bird, P., 2003. An updated digital model of plate boundaries. *Geochem. Geophys. Geosyst.*, 4, pp. 1027-1079

11 Mar 2011 Tohoku earthquake

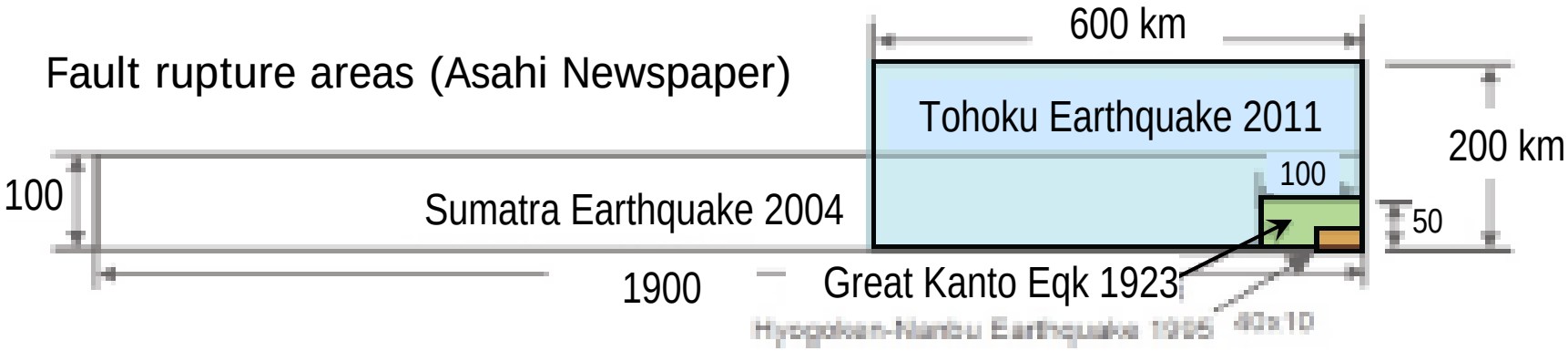
- Tohoku Region Pacific Offshore Earthquake (Eastern Japan Great Earthquake Disaster)
- M_W9.0, 2:45 PM local
- Epicenter 38.322N 142.369E, 32 km depth (72 km east of Tohoku)
- 14,000 killed 12,000 missing
- 77,000 housing units destroyed, 260,000 damaged
- 160,000 people displaced
- USD 600 billion loss?

Seismic setting & rupture

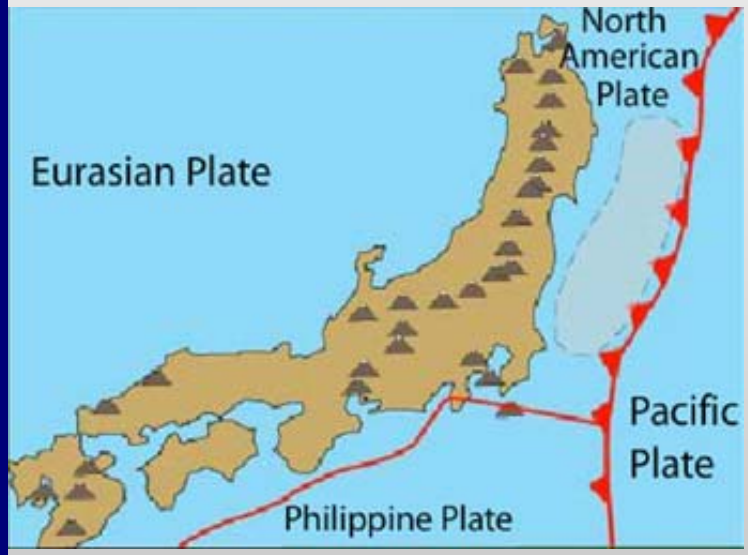


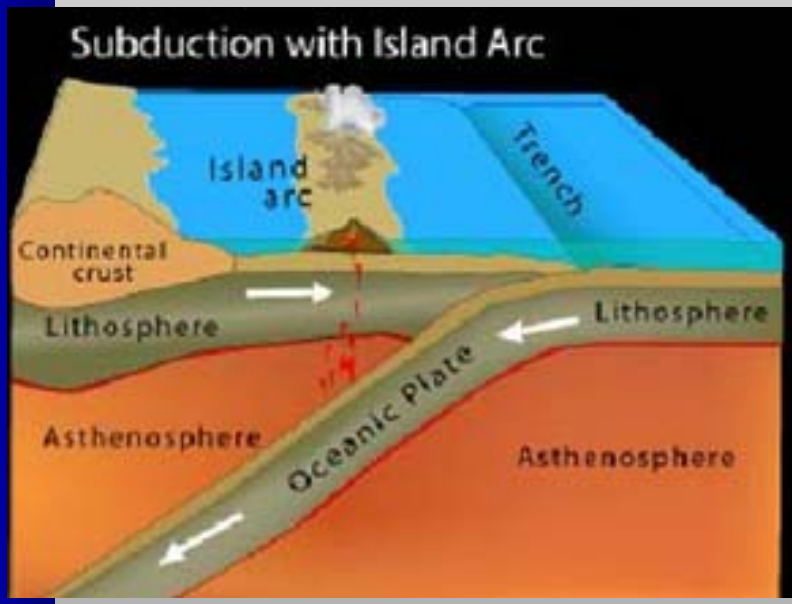


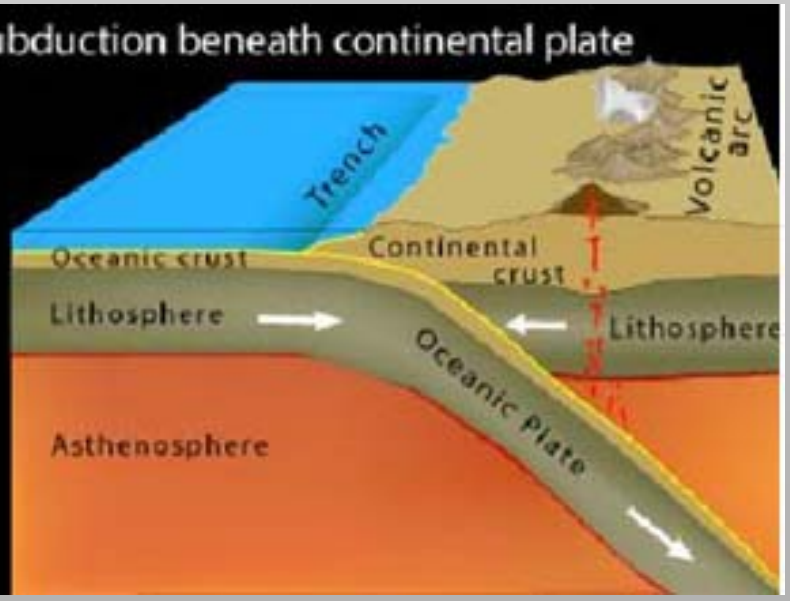
Fault rupture areas (Asahi Newspaper)



Meaning of “subduction”

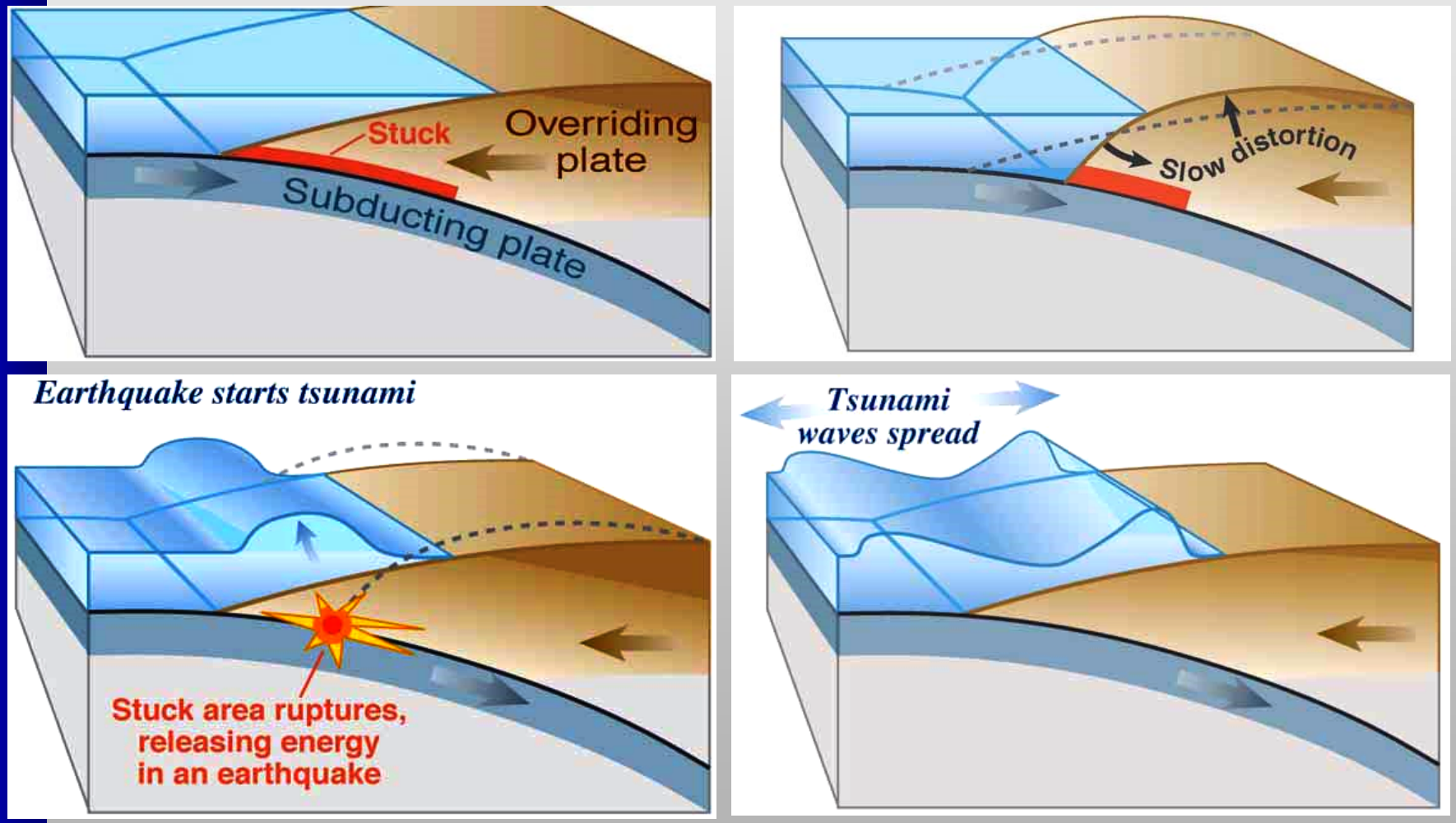






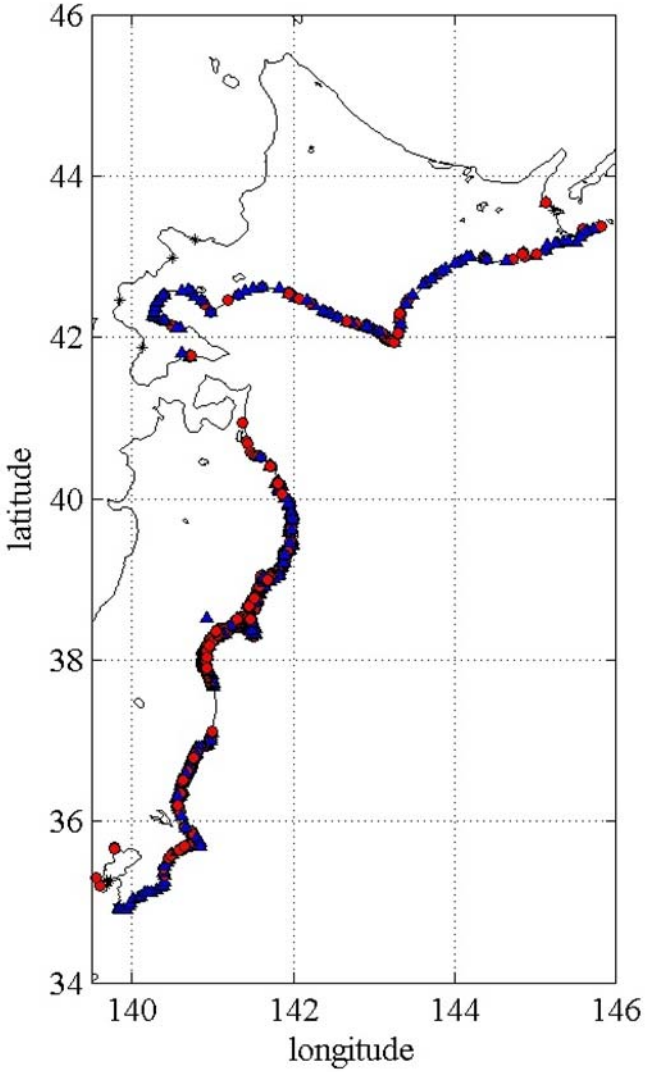
www.popularmechanics.com

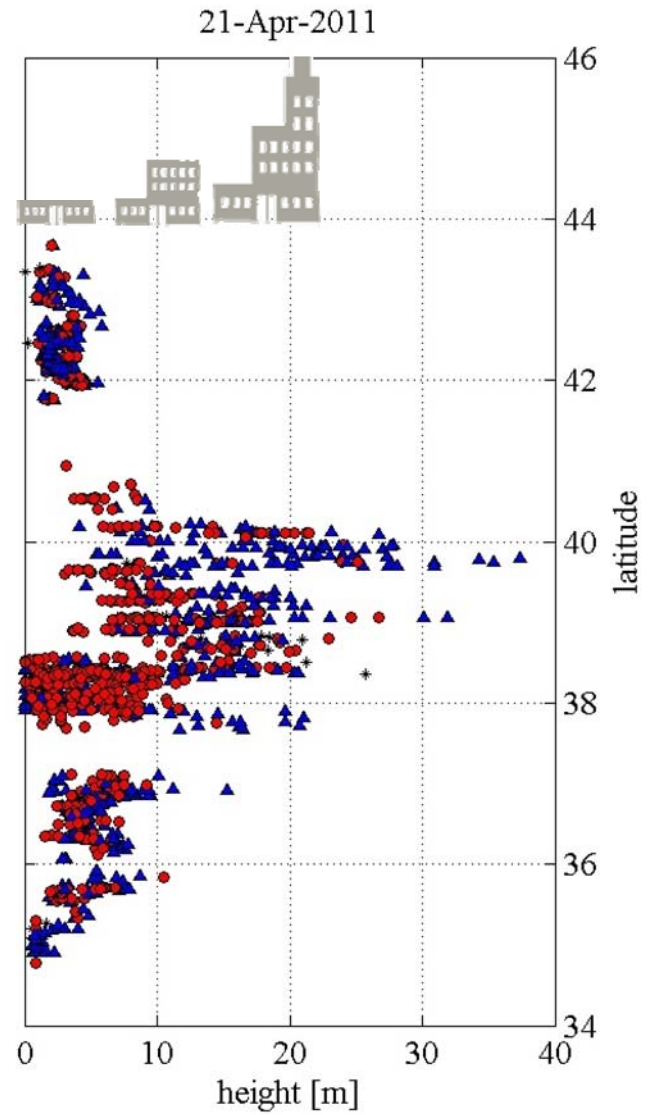
How tsunamis occur



http://pubs.usgs.gov/circ/c1187/

Tohoku tsunami runup





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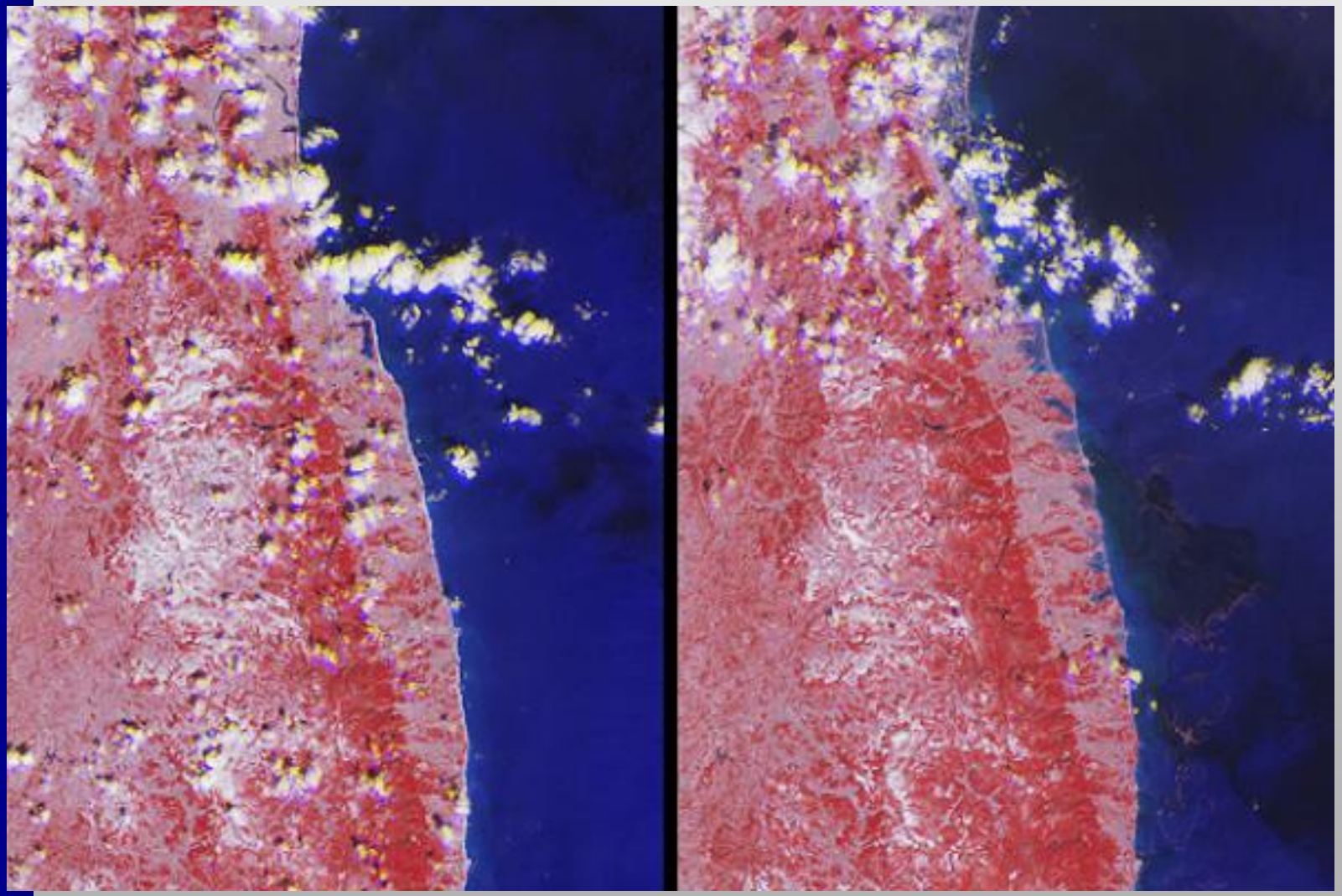
Inundation: 560 km^2 (220 mi^2)

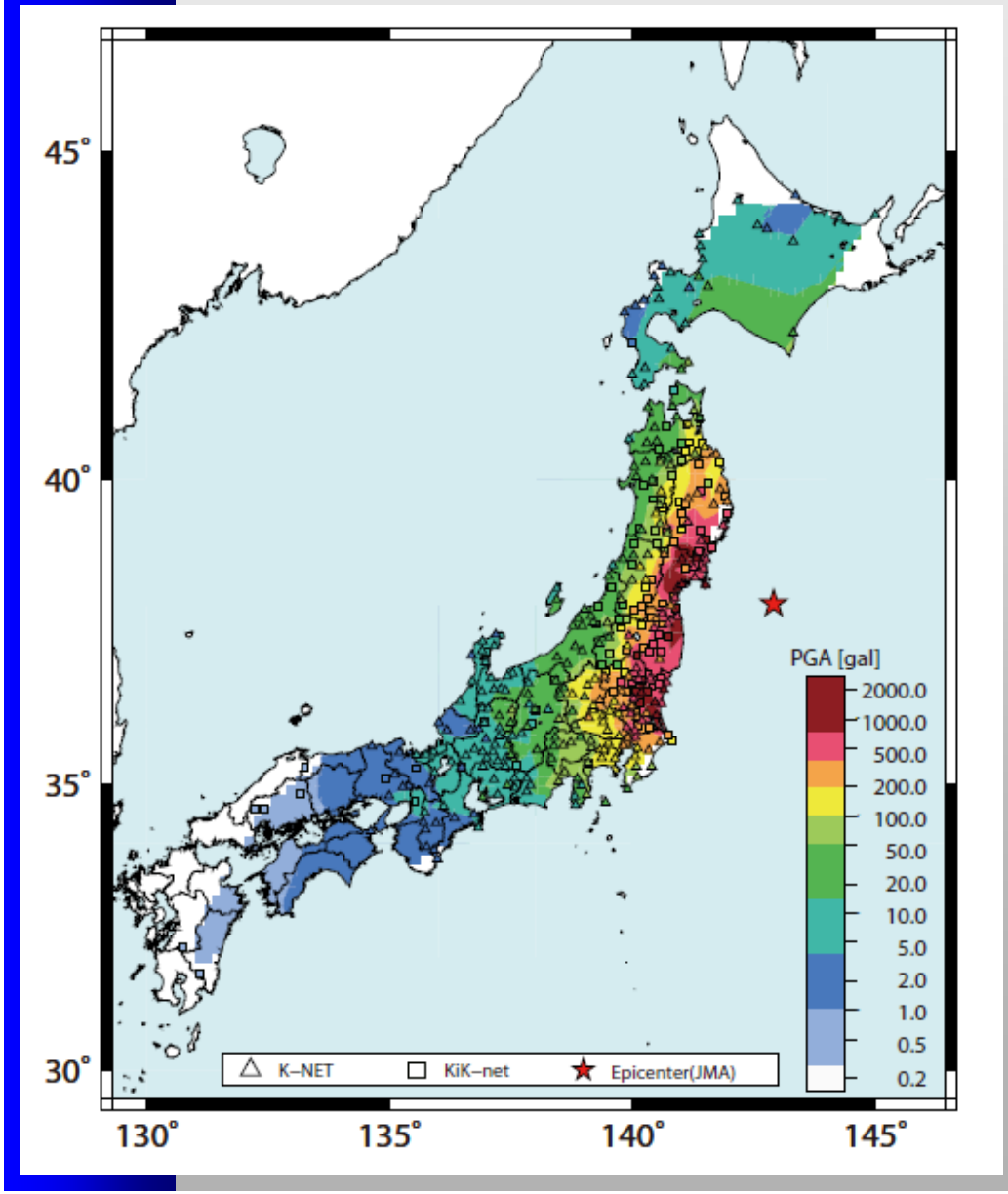


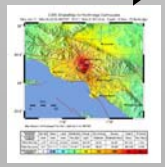
104 km

NASA Terra spacecraft, 16 Mar 2001

10:30 AM local 12 Mar 2011

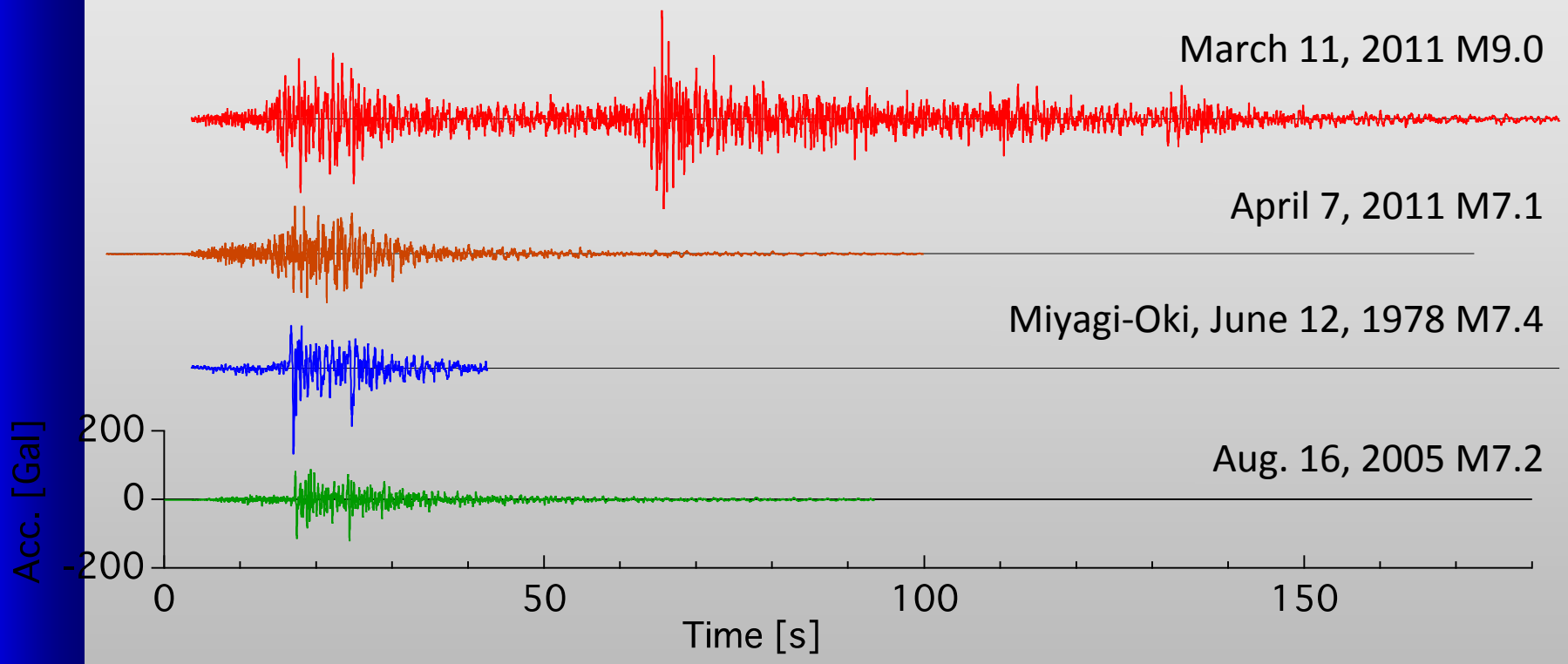
Ground shaking





1994 Northridge earthquake to scale

Long duration of strong shaking



Recorded strong motions from 2011 events compared to 1978 and 2005 Miyagi-ken Oki earthquakes at Sumitomo Building (near Sendai Station)

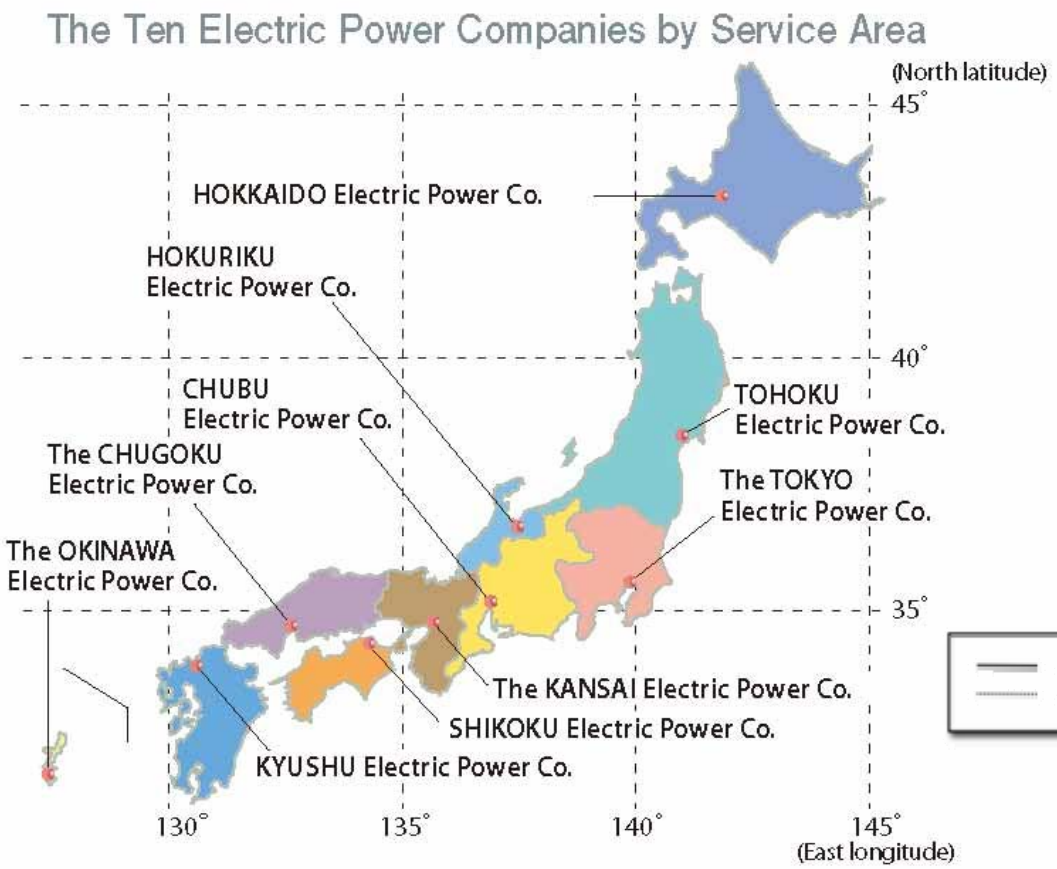
Courtesy: Prof. Motosaka, Tohoku Univ.

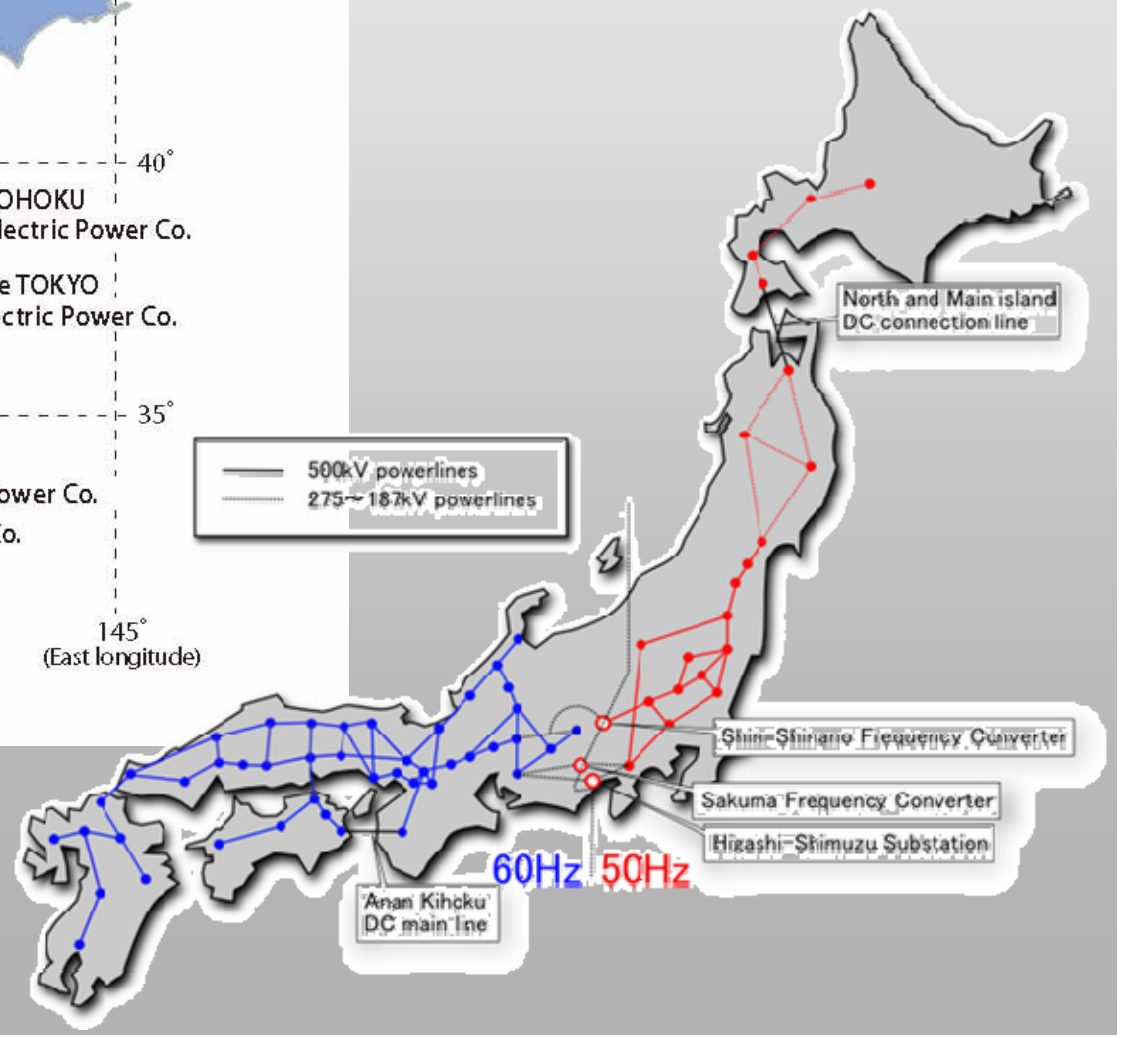
Tohoku earthquake
some engineering impacts

Shipping and ports

- ≥11 ships of 500-180,000 tons damaged, total 550,000 DWT
- 26,000 fishing vessels destroyed or unusable
- Scour damage to piers jetties and seawalls
- 15 ports damaged, 4 likely out of operation for months or more
- Tsunami or shaking damage to cranes & warehouses
- Ports with major damage handle 7% of industrial output

Electric Power





8 major fossil stations down + Fukushima; tsunami damage to EHV substations, T&D; 11% of generation capacity lost; but it's worse than it sounds...

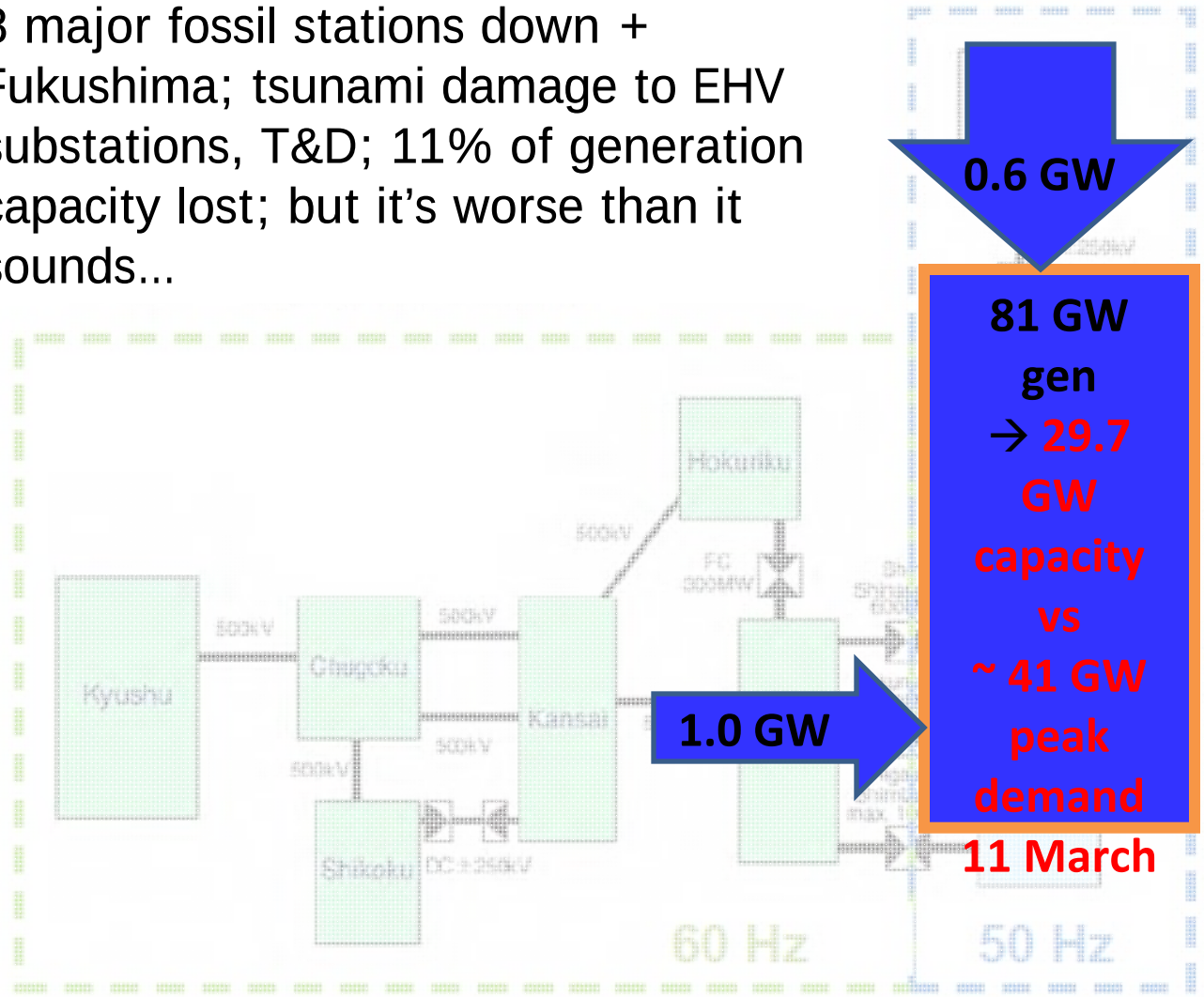


Figure 11 Schemat

Rolling brownouts coming this summer

TEPCO & Tohoku service area

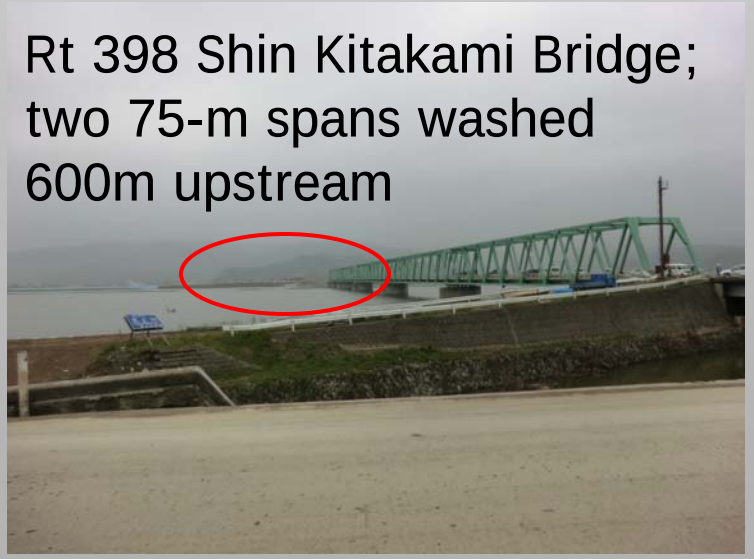
Building damage

- Most building damage was caused by tsunami
- Modest amounts of shaking & liquefaction damage
- 1-2m tsunami destroyed woodframe buildings
- 12m is sufficient to overturn 3-story RC buildings

Onagawa, 35 mi NE of Sendai

Roads and railway damage

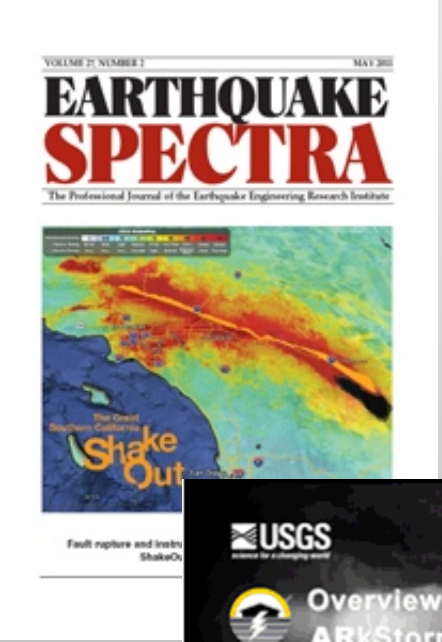
- Closure caused by scour & debris
- Flotation of sewers from liquefaction
- Bridges pushed from their piers
- Lifeline interaction: road damage hinders other repairs

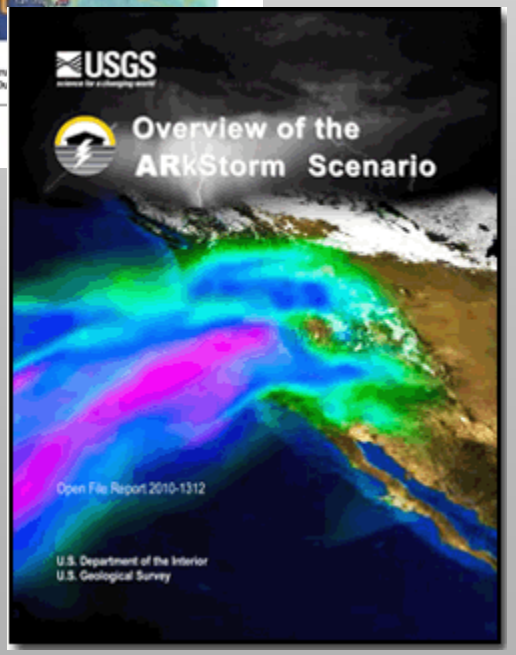


Preview of the next USGS Multihazards Demonstration Project: Tsunami Scenario

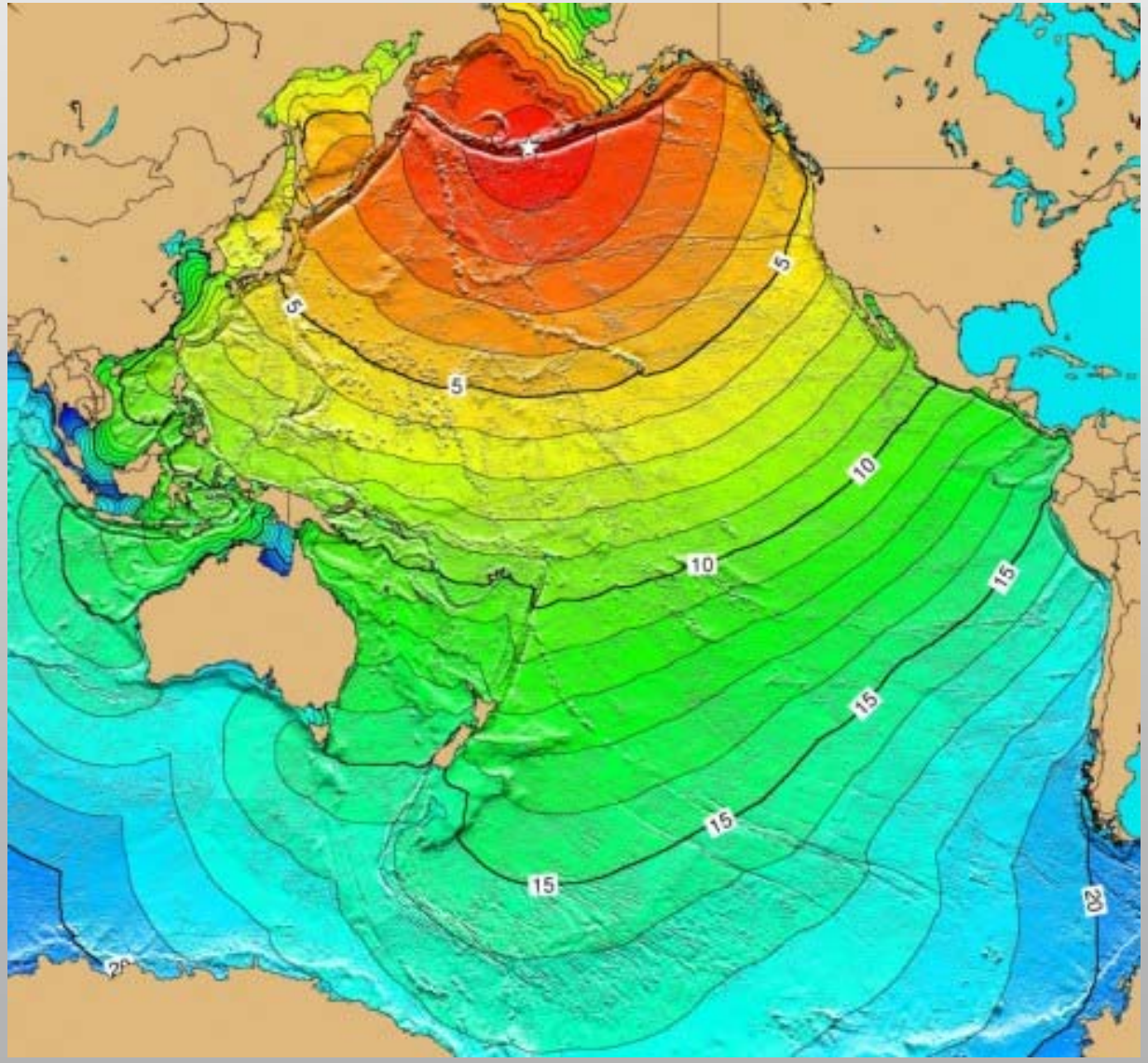
Multihazards Demonstration Project

- Objective: show how science can enhance resiliency
- Collaborative studies designed with & for users, who wanted scenarios
- ShakeOut Scenario: hypothetical M7.8 SoCal earthquake, $215B
- ARkStorm: severe California storm, $725B loss, likelihood similar to ShakeOut
- Next: Tsunami Scenario, a M_W9.0 eastern Aleutian earthquake

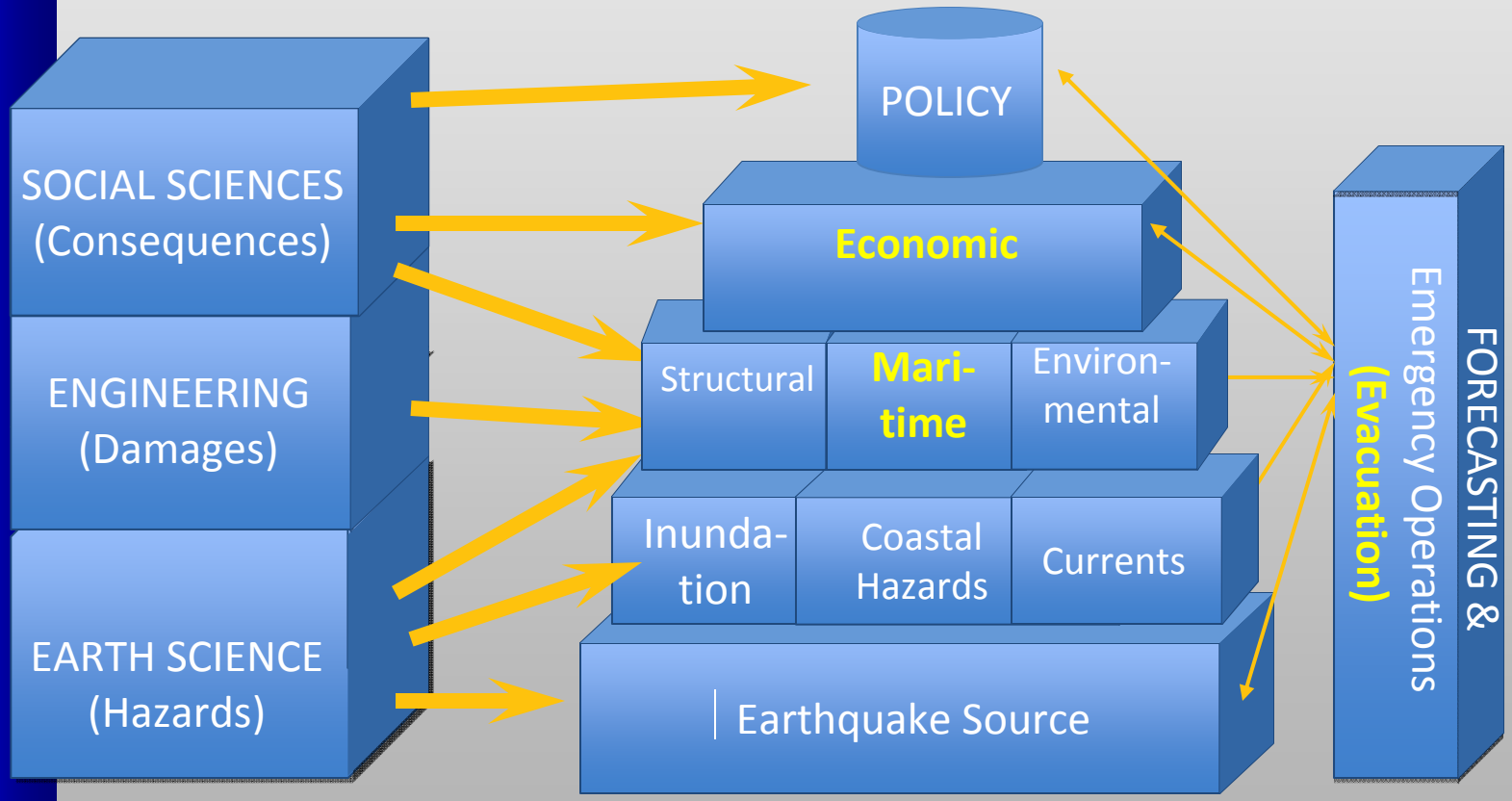




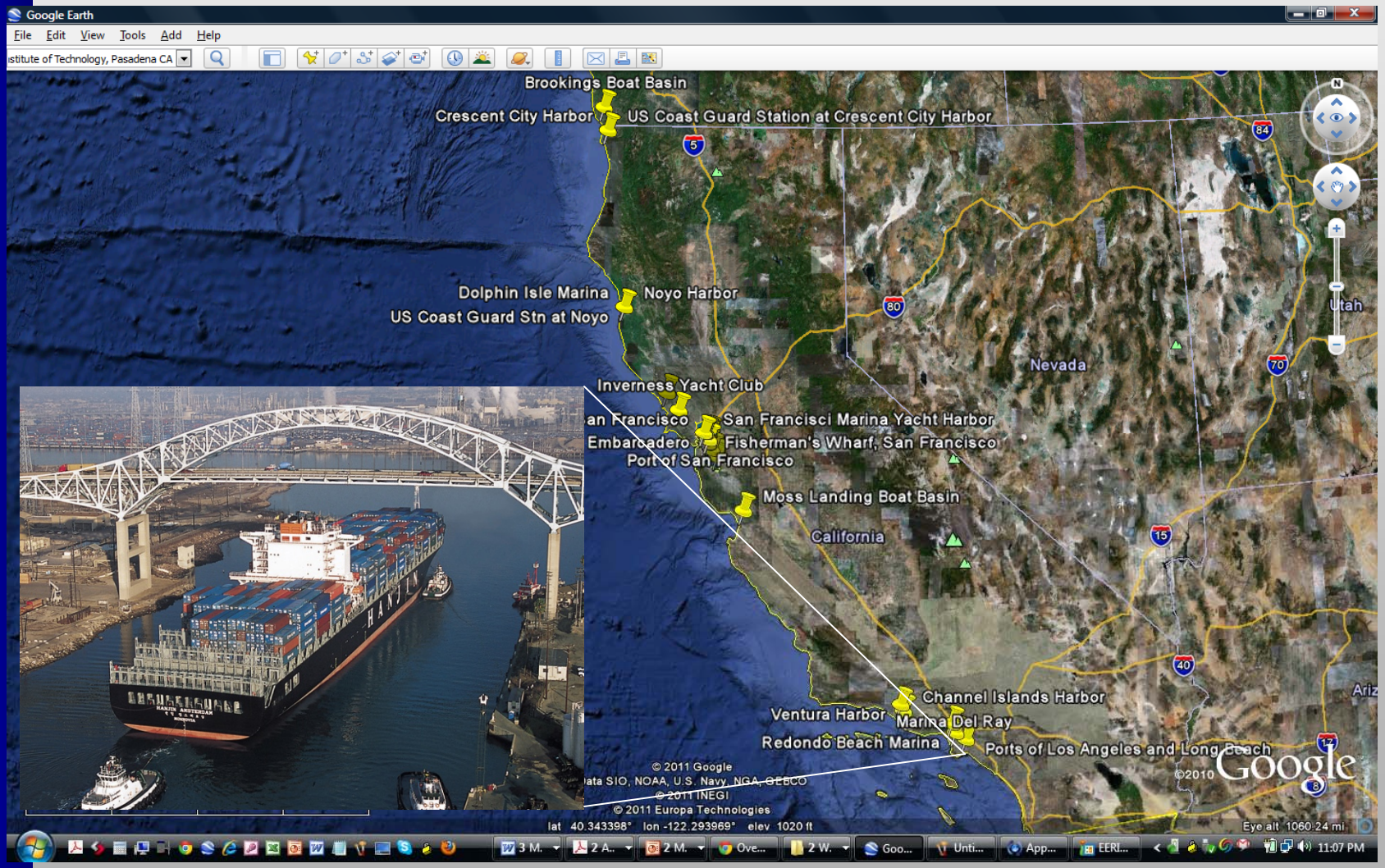
1957 M_W8.6 Aleutian earthquake & tsunami



Tsunami scenario elements



30 ports and boat basins



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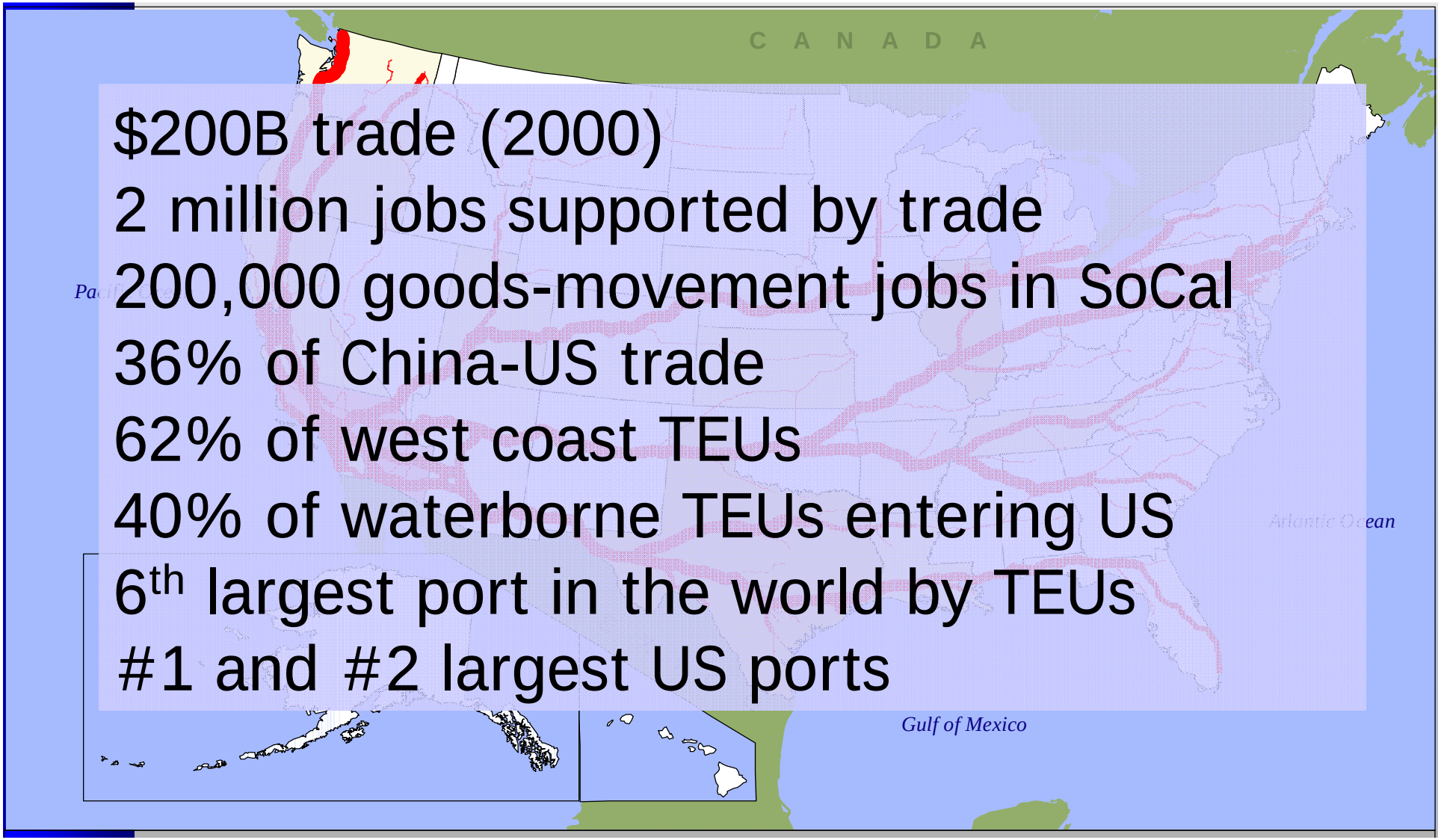
Ports of LA and Long Beach



$200B trade (2000)

2 million jobs supported by trade

200,000 goods-movement jobs in SoCal

36% of China-US trade

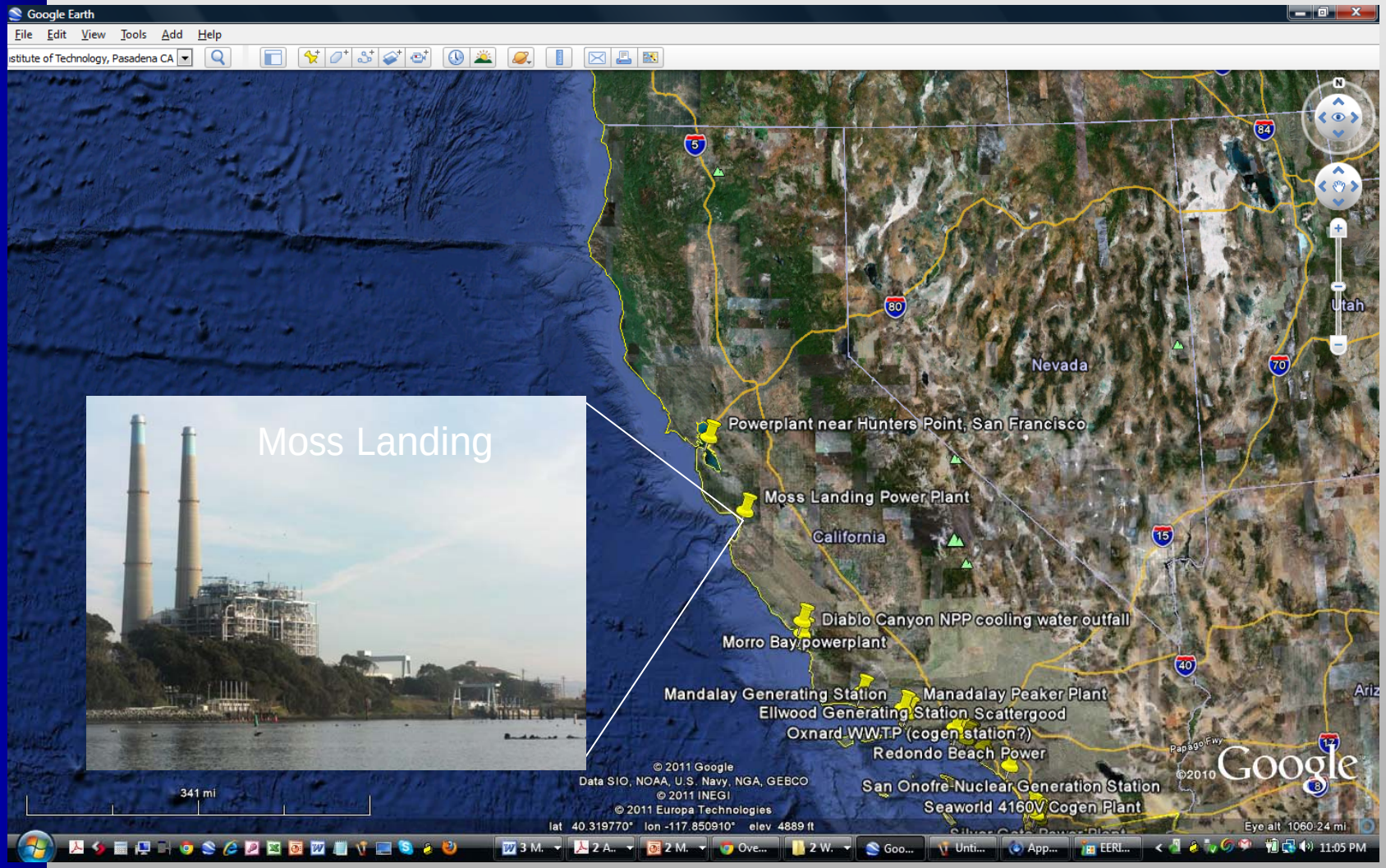
62% of west coast TEUs

40% of waterborne TEUs entering US

6th largest port in the world by TEUs

#1 and #2 largest US ports

26 power generation stations



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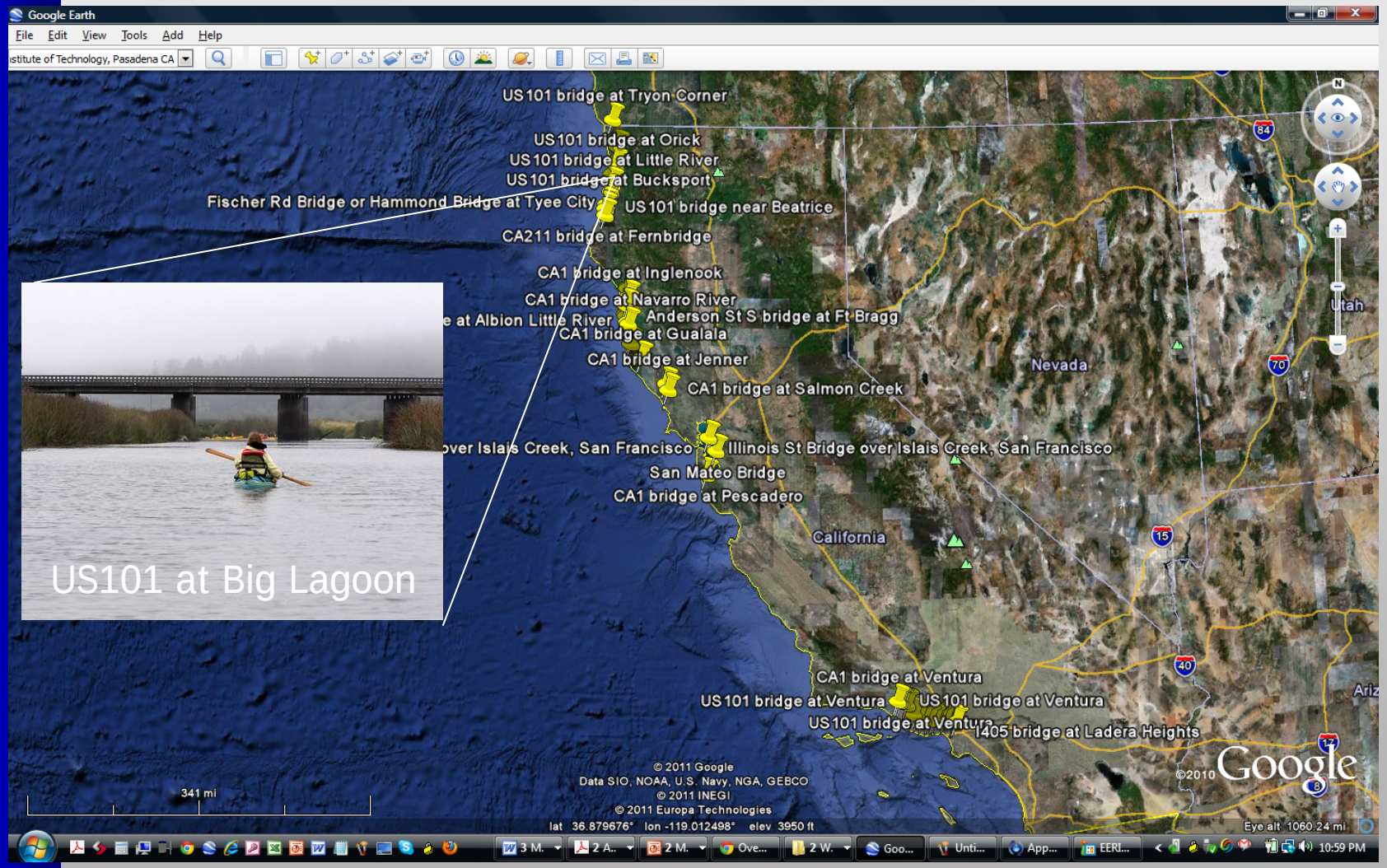
50+ highway bridges



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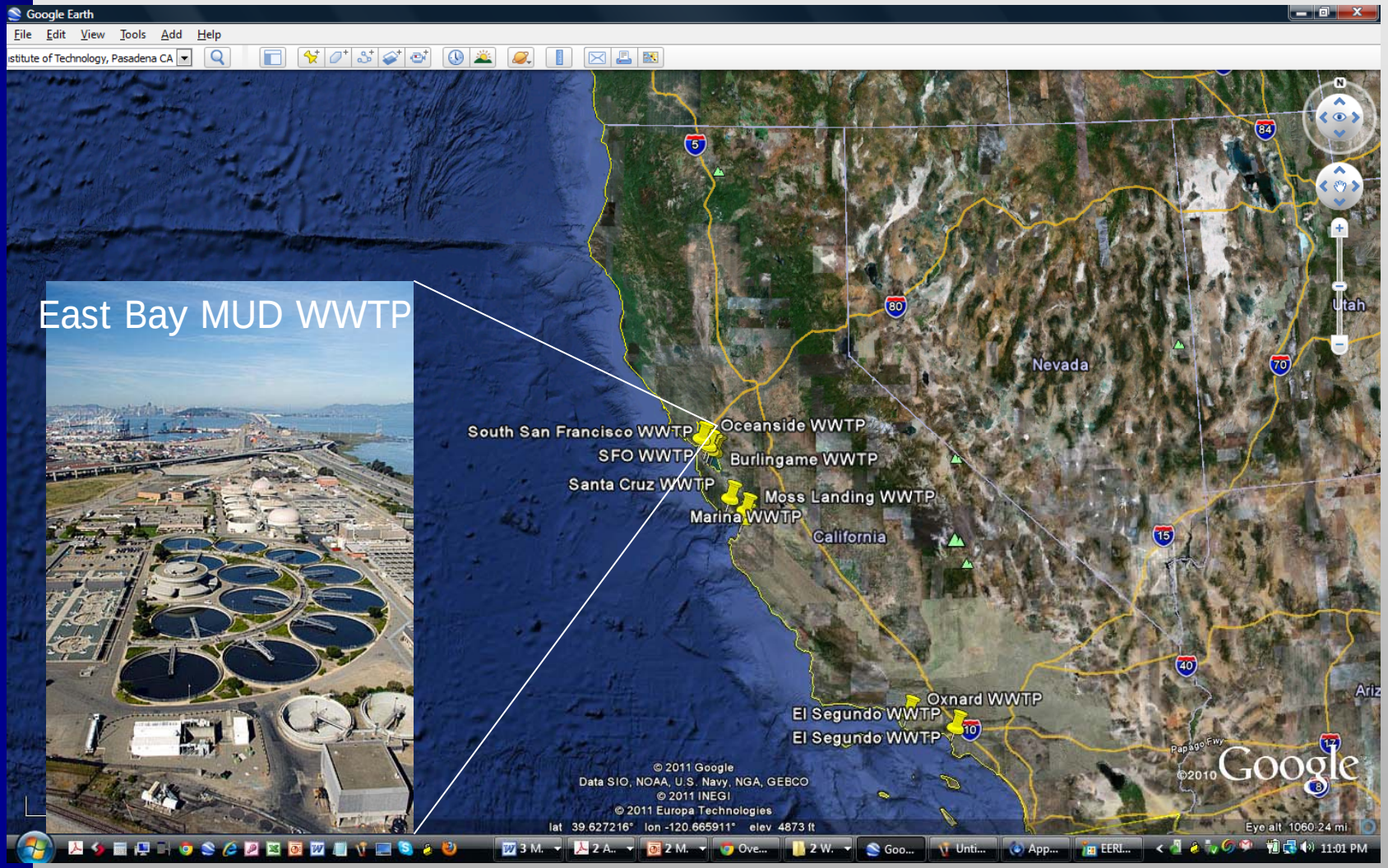
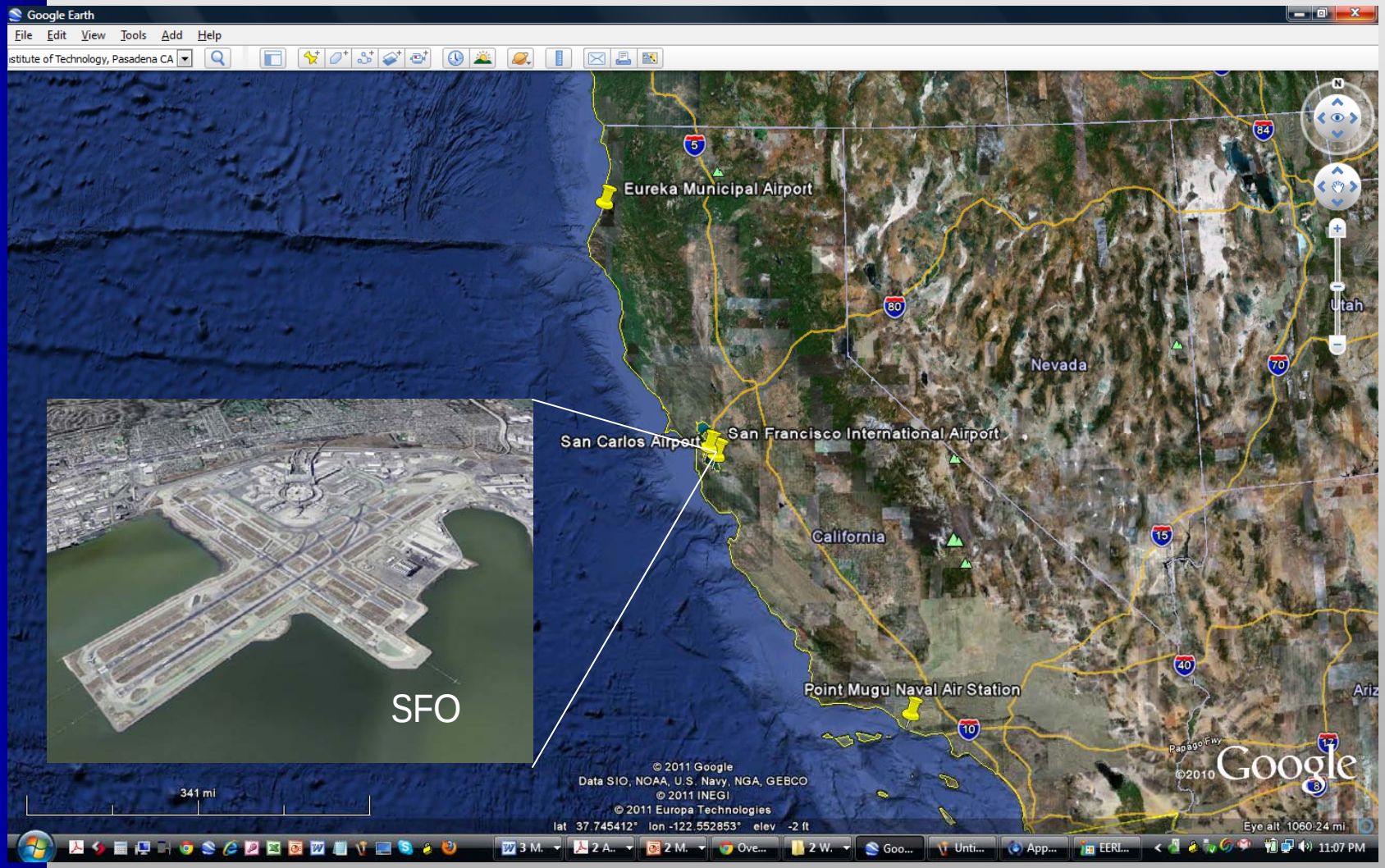
11+ wastewater treatment plants



4 airports


Google Earth
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Eureka Municipal Airport
San Carlos Airport
San Francisco International Airport
Nevada
California
Utah
Point Mugu Naval Air Station
SFO
341 mi
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lat 37.745412° lon -122.552853° elev -2 ft
Eye alt 1060.24 mi
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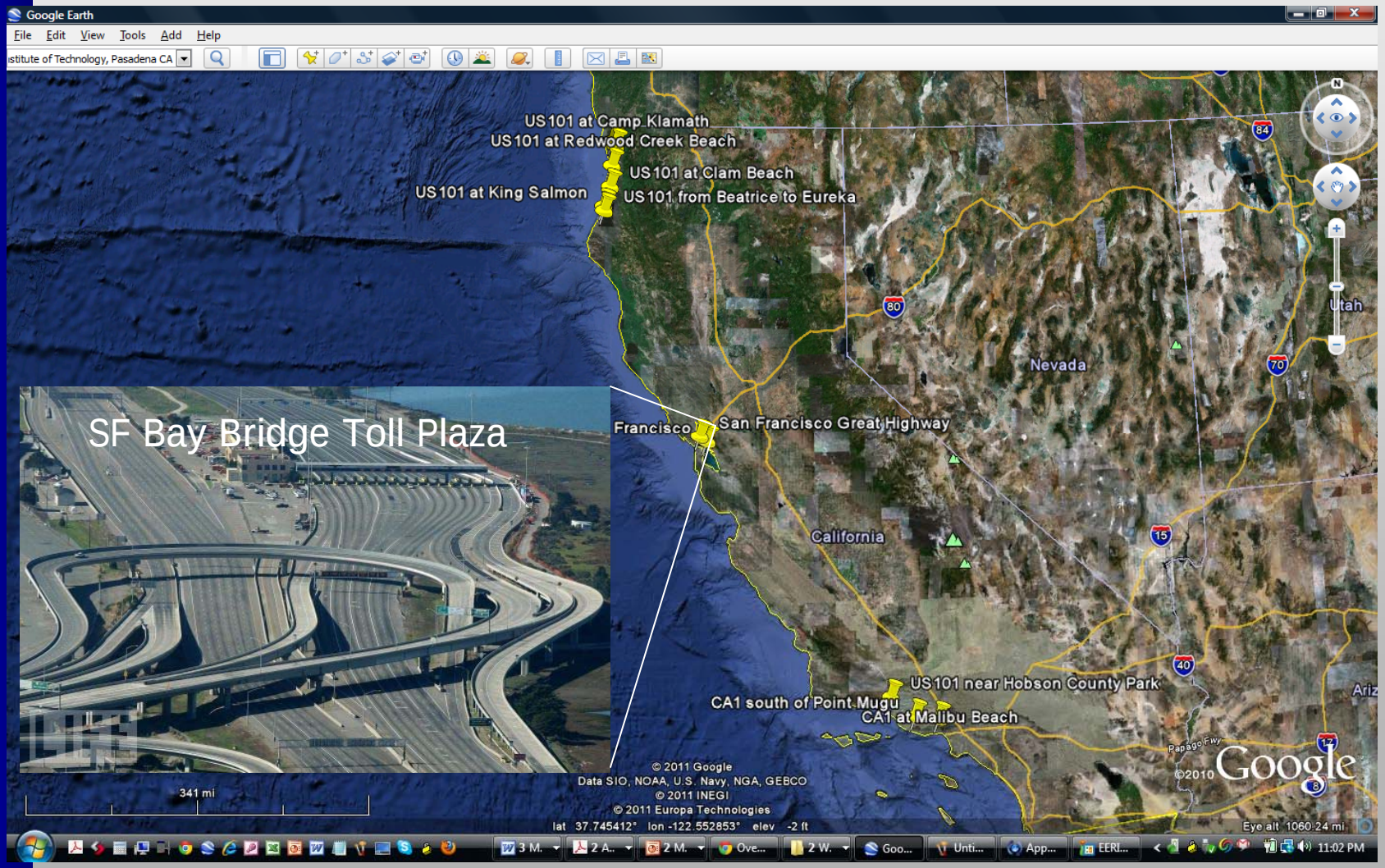
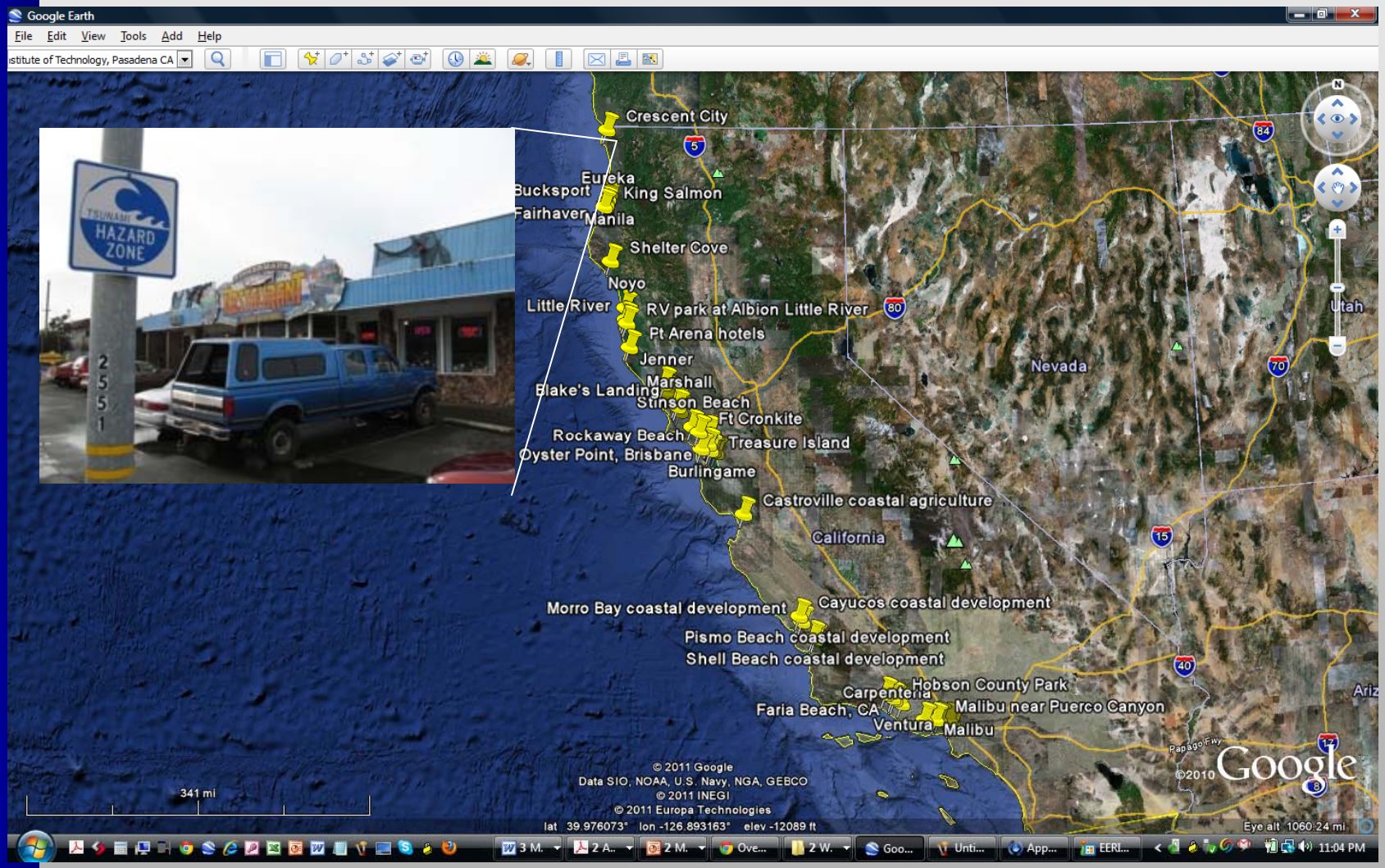
11:07 PM

11+ stretches of coastal highway



50 coastal communities



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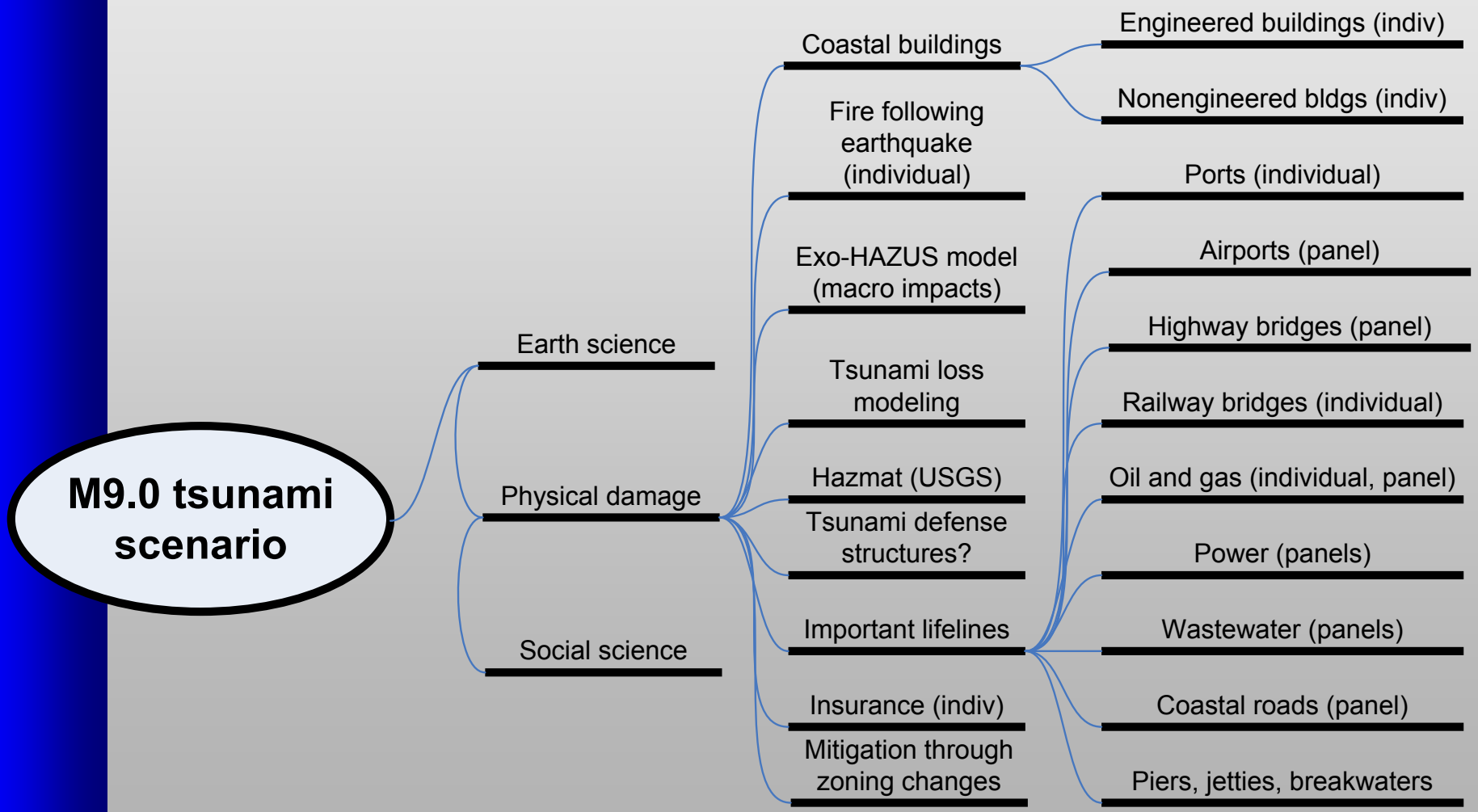
Engineering studies 2011-2012



Conclusions

- Actuarial evidence can help manage risk of events like those in the past
- Science can help us deal with hazards and vulnerability of a changing world, e.g.,
  - Climate change & demographic shifts
  - New design & construction techniques
  - Demand surge
  - Evaluating mitigation activities & risk transfer techniques
  - Understanding underlying dynamics, to identify levers to reduce risk

Thanks

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