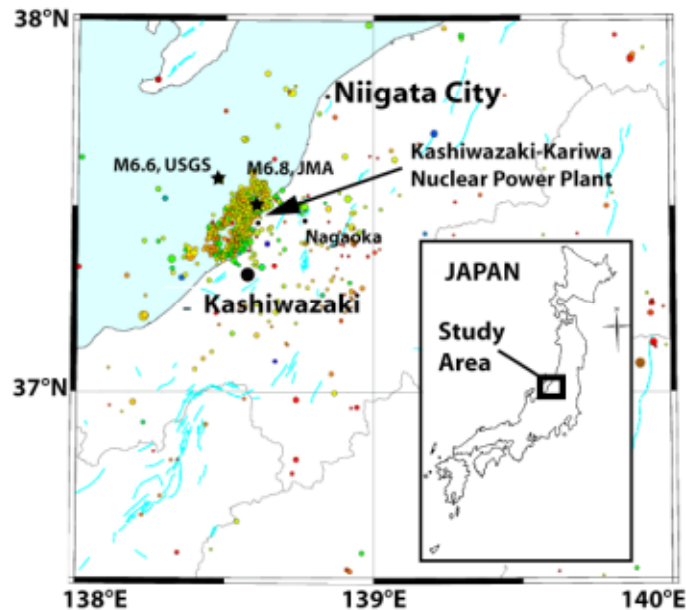


# GEER Response to the Niigata Chuetsu-Oki Earthquake of July 16, 2007



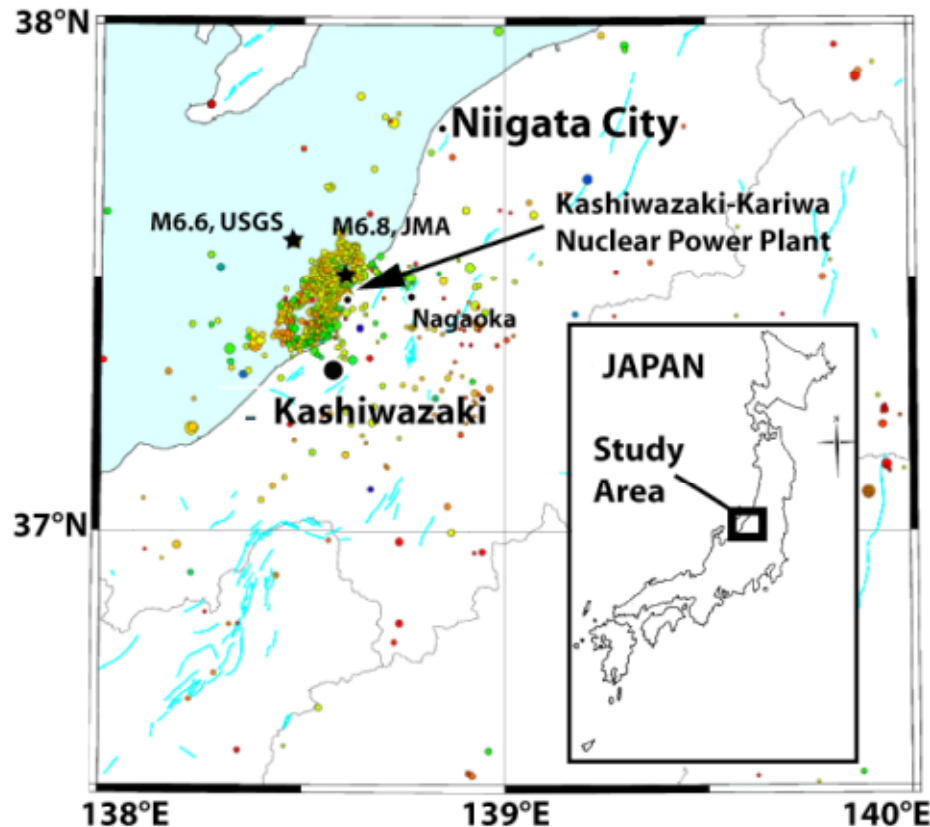
Robert Kayen, Ph.D., P.E.  
Research Civil Engineer  
U.S. Geological Survey  
Menlo Park, CA



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# Niigata Chuetsu Oki Earthquake of July 16, 2007



Main shock located by USGS and JMA, moment tensor solutions and aftershock patterns indicated two possible fault planes.

Rupture was immediately offshore KK-NPP



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# Impacts of the M6.6 Niigata-ken Chuetsu-oki Earthquake, July 16, 2007

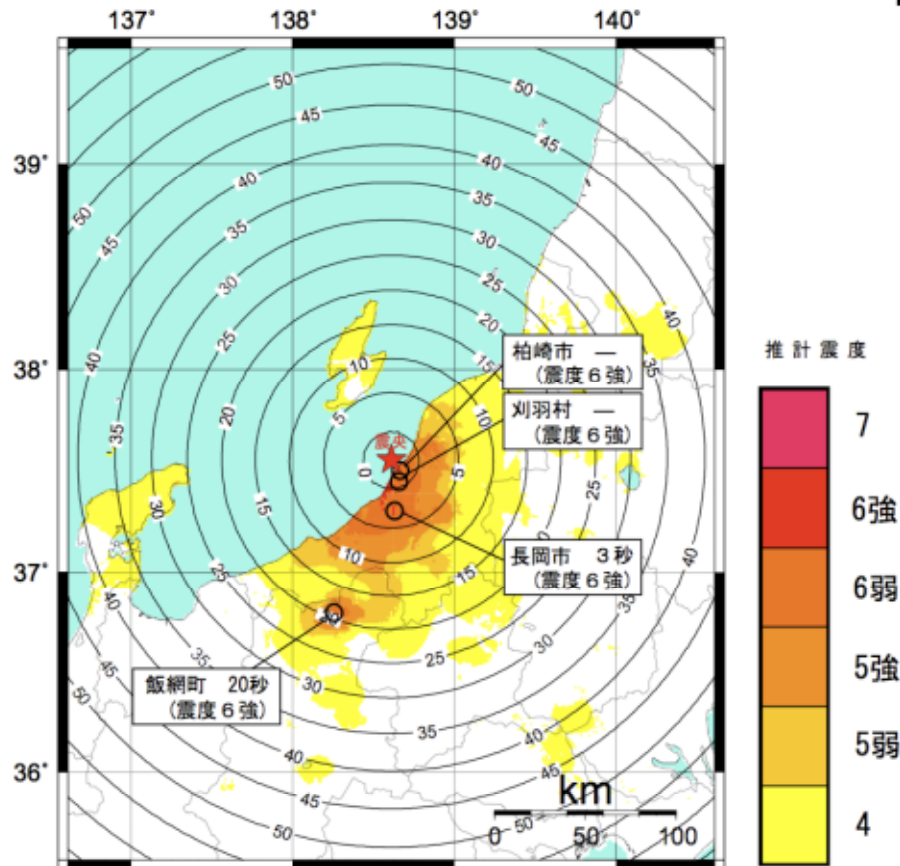


図1-3-2 緊急地震速報の第1報提供から主要動到達までの時間(秒)及び推計震度分布

- Occurred at 10:13 am on a national holiday
  - Impact area in more rural region, 80km south of Niigata
- 11 deaths (10->70 years old) and nearly 2,000 injuries. Most from house collapse.
- Housing damage: 1,096 collapsed
  - 2,679 partially collapsed and 27,807 partial damage
- Public/other buildings damaged: 13,292
- Main city impacted:
  - Kashiwazaki (pop 90,000)



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# GEER Reconnaissance

Report at:

<http://pubs.usgs.gov/of/2007/1365/>

And GEER web site

GEER members: Robert Kayen (Leader), Scott Ashford, Scott Brandenberg, Brian Collins, Steve Dickenson, Yohsuke Kawamata, Yasuo Tanaka, Kohji Tokimatsu,

Non-Geer Participants: Santiago Pujol (EERI Co-Leader), Laurie Johnson, Norm Abrahamson, Toshimi Kabeyasawa, Lloyd Cluff, Hidetaka Koumoto, Nanako Marubashi, Clint Steele, Joseph Sun, Ben Tsai, Mark Yashinsky, Kim Yousok



## Investigation of the M6.6 Niigata-Chuetsu Oki, Japan, Earthquake of July 16, 2007

Robert Kayen, Brian Collins, Norm Abrahamson, Scott Ashford, Scott J. Brandenberg, Lloyd Cluff, Stephen Dickenson, Laurie Johnson, Yasuo Tanaka, Kohji Tokimatsu, Toshimi Kabeyasawa, Yohsuke Kawamata, Hidetaka Koumoto, Nanako Marubashi, Santiago Pujol, Clint Steele, Joseph I. Sun, Ben Tsai, Peter Yanev, Mark Yashinsky, Kim Yousok



Open File Report 2007-1365

2007

U.S. Department of the Interior  
U.S. Geological Survey



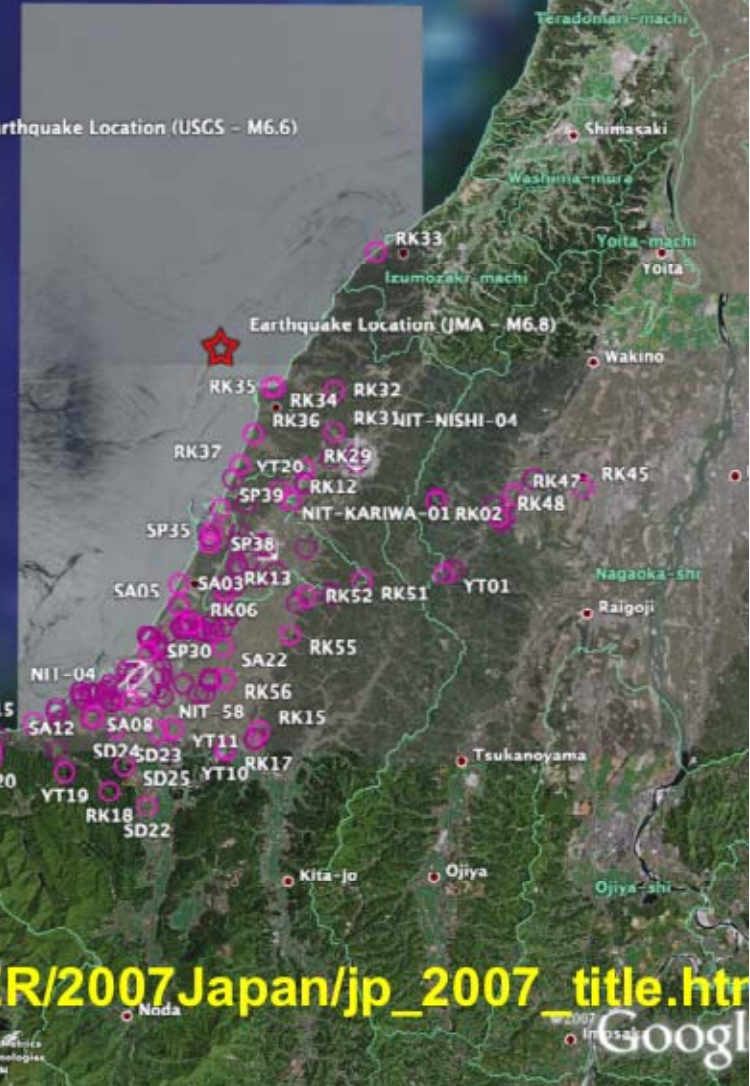
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# Google Earth Mapping



Earthquake Location (USGS - M6.6)



Earthquake Location (JMA - M6.8)



[http://gees.usc.edu/GEER/2007Japan/jp\\_2007\\_title.htm](http://gees.usc.edu/GEER/2007Japan/jp_2007_title.htm)

18.2 km

Image © 2007 TerraMetrics  
© 2007 Google Technologies  
© 2007 ZENGIN  
Image NASA

Google



## RK34

- Site Number -- RK34
- Name -- Coastal Landslides South of Route 373 - Several colluvial/residual slides in this area. Beginning in the north, five small (volume Less than 25 m<sup>3</sup> each), shallow failures were observed behind some nearby structures. These are considered minor failures. Several other major failures were observed and investigated in more detail. The road in this location were closed due to Slides 1, 2, 3 as described below:
  - Slide 1 - Located in previous area of instability, a shotcrete stabilization system is in effect for the bottom 50 m of this slope (total slope height is ~115m), and overlain with a wire-mesh rock deflection system. Slide is 50-60 m wide, 65 m long, Less than 1m thick. Slide initiated above shotcrete slope, moved into wire-mesh, causing failure of meshing and pulling out of steel wire-mesh steel supports. Wire-mesh caught most of debris, depositing the majority on the road, with only slight quantity of debris over road edge. Failure plane has approximate 60° inclination.
  - Slide 2 - Similar to Slide 1. Slide is 10 m wide, 15 m long, 0.5m thick. Failure plane has approximate 70° inclination.
  - Slide 3 - Similar to Slide 1. Slide is 10 m wide, 15 m long, 1 m thick. Failure plane has approximate 50° inclination. At this location, the wire-mesh and supports were torn away from the slope.
  - Slide 4 - Similar to Slide 3, however slide debris did not reach wire-mesh protection, and was instead deposited in the middle of the slope. Slide is 10 m wide, 25 m long, 0.5 m thick. Failure plane has approximate 50° inclination.
  - Slide 5 - Slide area is below road with head scarp located in the coast-side lane of the road. Site could not be photographed, and failure dimensions are unknown.
  - Slide 6 and 7 - Slide area consists of two slopes with raveling failures that toe onto the beach. Only minimal debris was observed on the beach, suggesting that this slope has undergone failure in the recent past. Failure plane has approximate 55° inclination.
  - Slide 8 - Several additional areas of shallow landsliding were observed to the south in this area, no additional details were noted.
- Lat (dec. deg.) -- 37.48455
- Lon (dec. deg.) -- 138.62435
- Photos -- RK, BC
- Noted -- Landslide
- Noted -- Road Embankment Failure
- Noted -- Pavement Failure
- Click site photo for full resolution view



- [Search InfoBank](#)

RK40

SP33

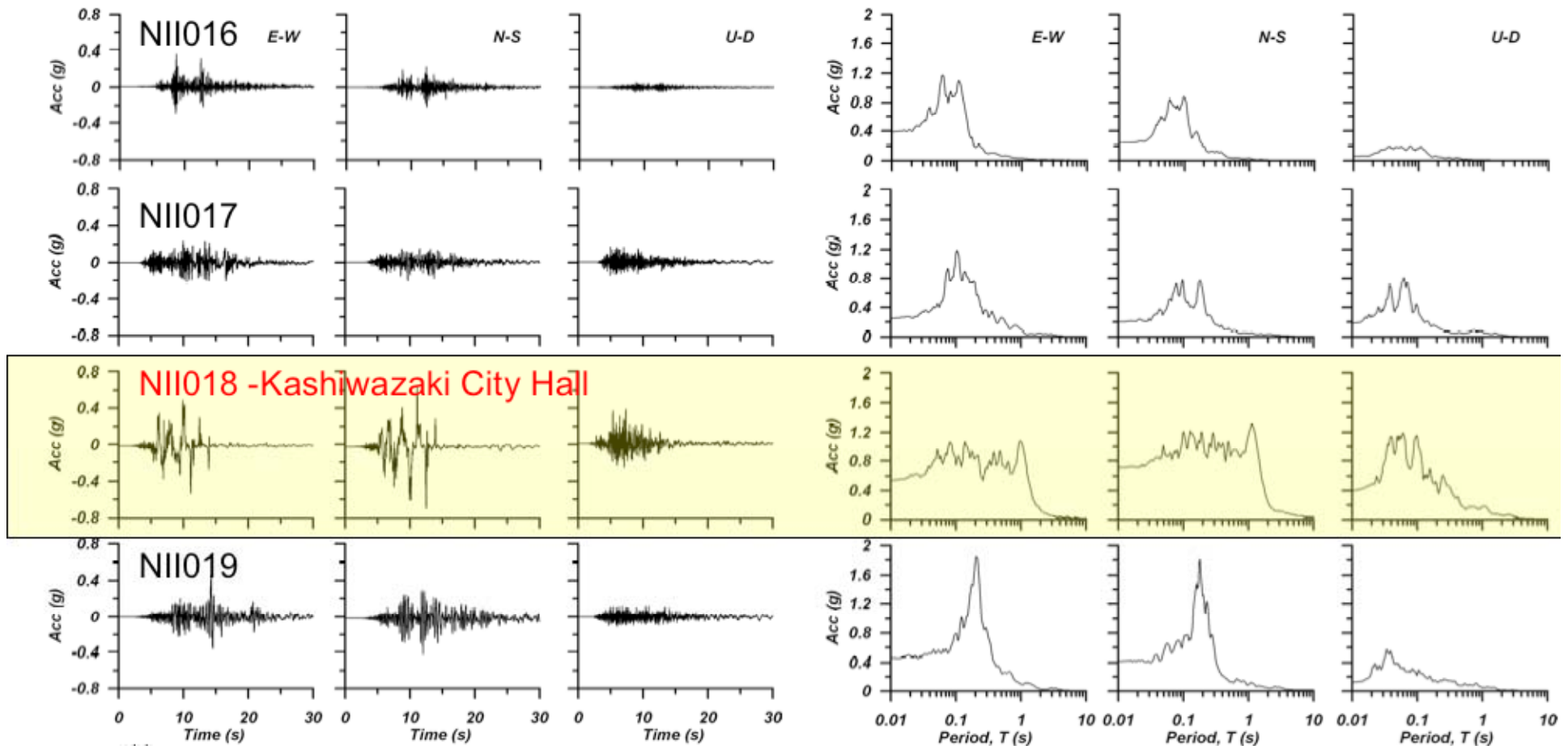
RK44

RK01

LIDAR data collection of  
the most significant  
geotechnical damage



# Liquefaction near Kashiwazaki City Hall -NIIG018





# Kashiwazaki-Kariwa NPP

Worlds Largest  
Facility, 7-unit, 8GW

16 km from JMA  
epicenter

99 instruments

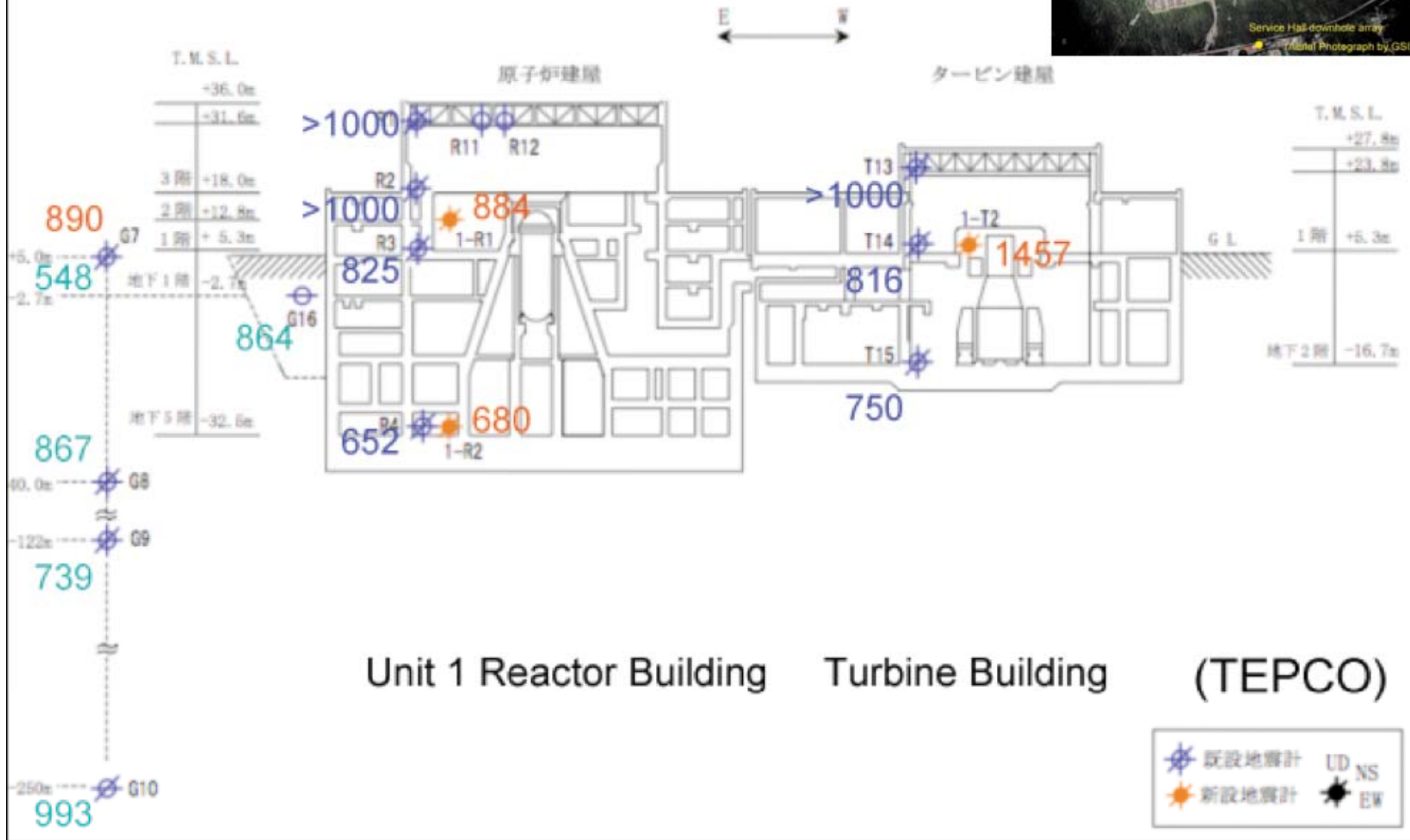
33 successful  
recordings



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# Recorded Maximum Acceleration in EW direction



## Liquefaction damage at the KK-NPP: Road Access





## Liquefaction damage at the KK-NPP: Settlement of piers





- Lateral spread and settlement of dune sand below the grade beam supporting a KK-NPP high-tension power-line tower



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# Landslide Damage: Oumigawa Train Station

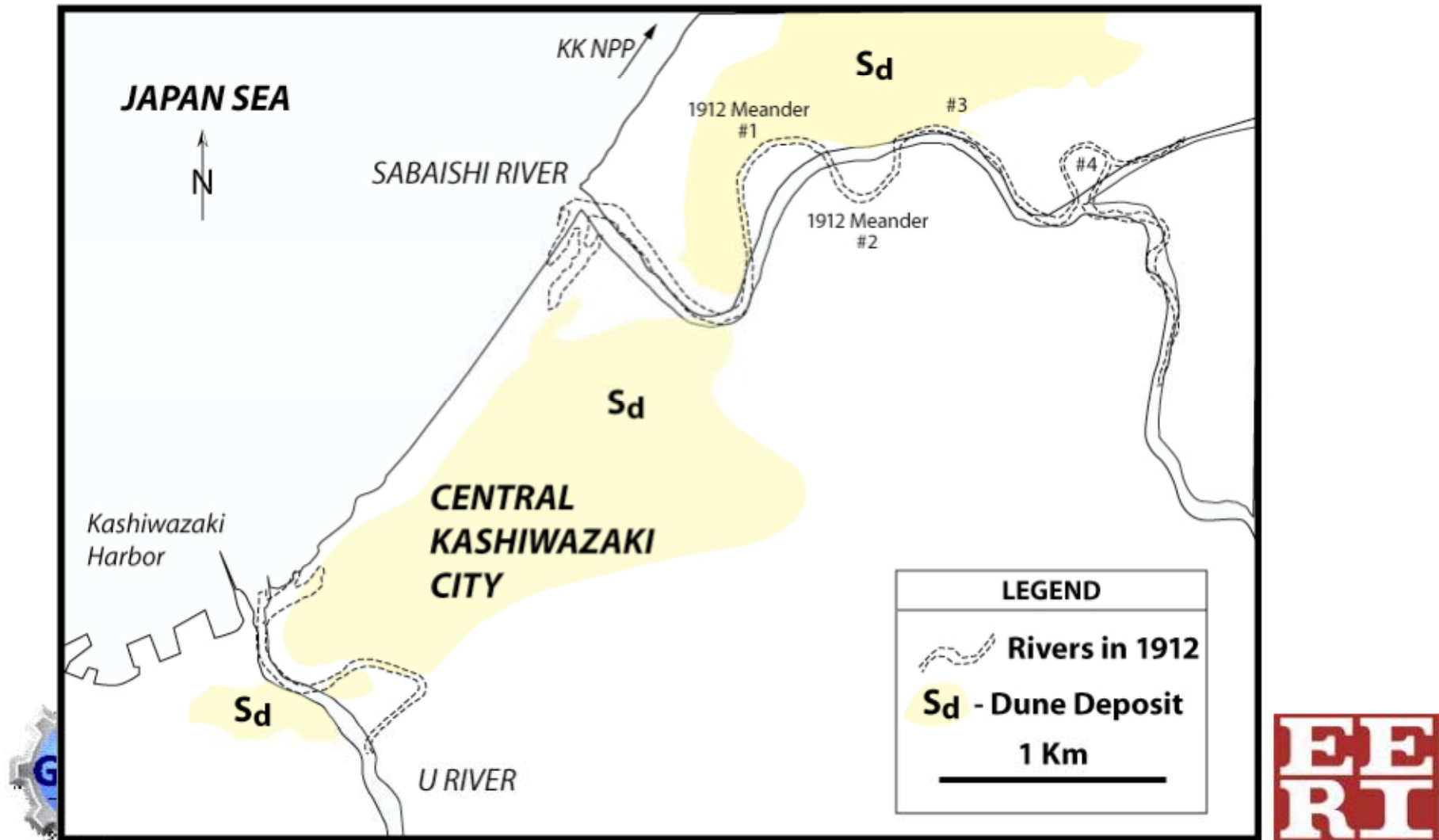




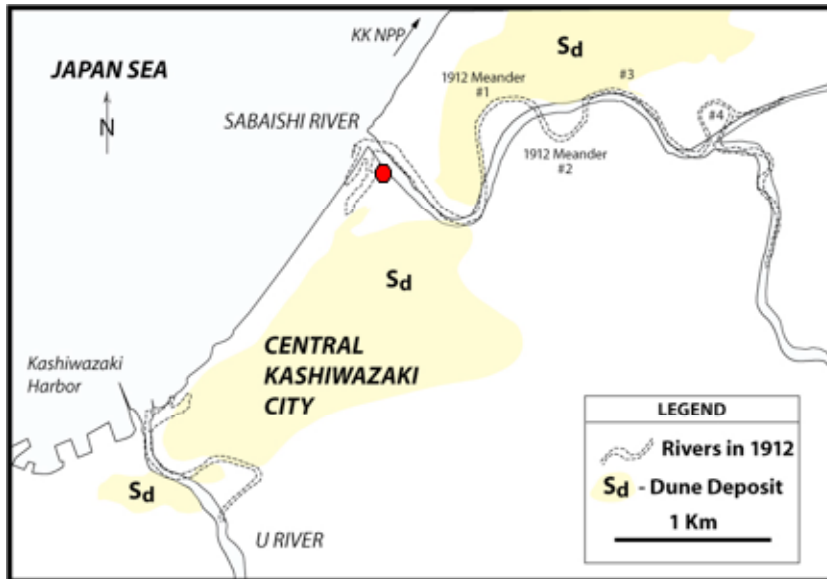
# Cut-and-fill road embankment failures were common



Liquefaction was most severe along the old buried river meanders of the U and Sabaishi Rivers

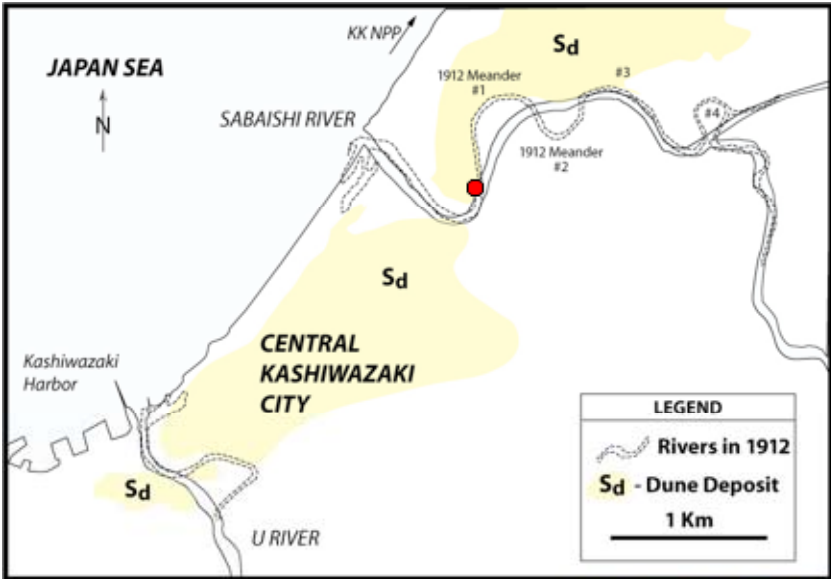


# Liquefaction pulled apart Kashiwazaki waste water treatment plant



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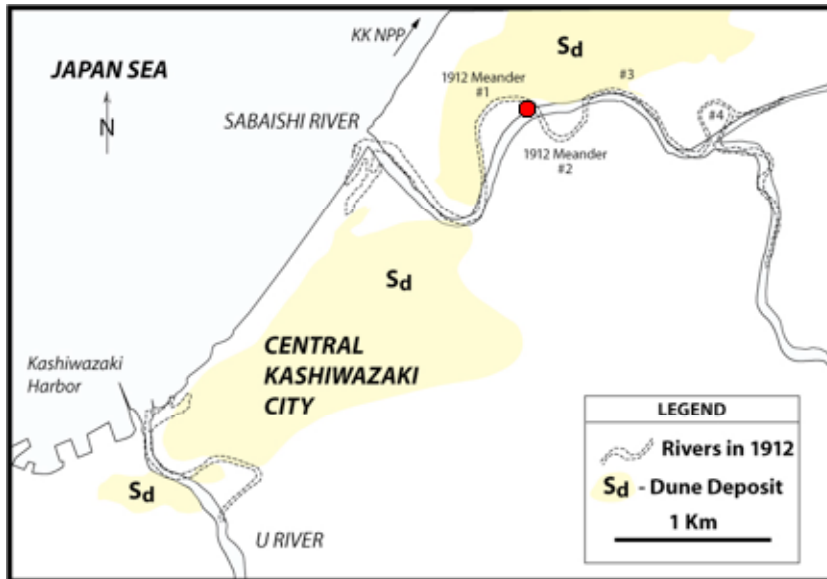




# Uplift and failure of water cistern, Sabaishi River



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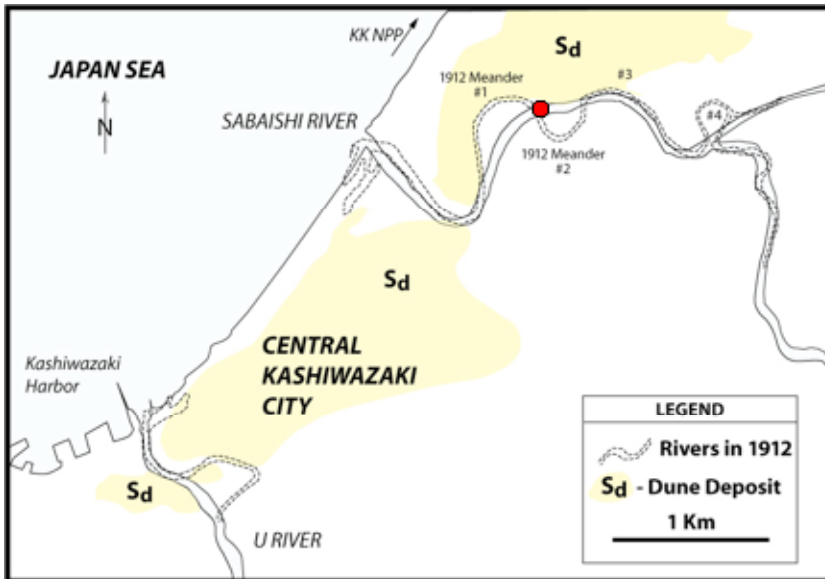


# Massive lateral spread on the old Sabaishi river course



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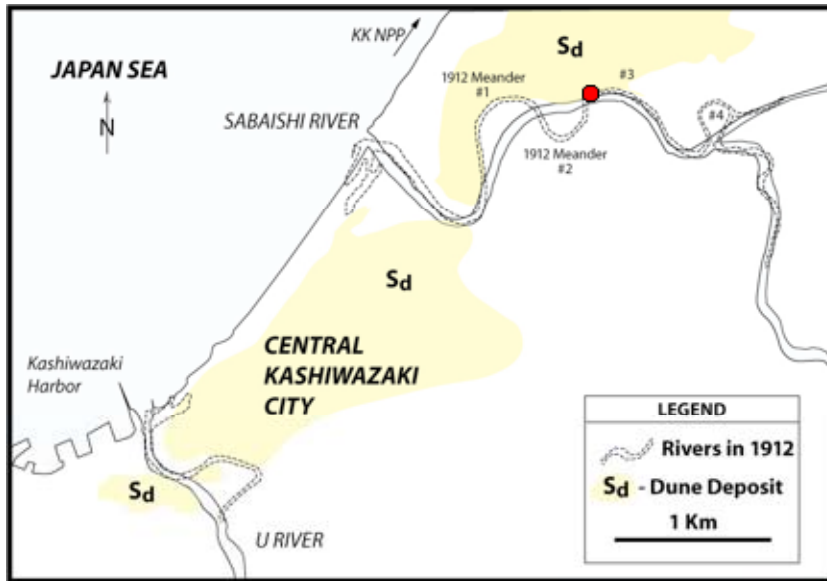
River narrowing due to embankment settlements:  
 Bridge abutment cracking,  
 Elastomeric bearing strains



Geo-Engineering and Earthquake Resistant  
 Turning Disaster into Opportunity



# Approach fill settlement impeded emergency response: Sabaishi River



Geo-Engineering Earthquake Research  
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# Poor performance of trench backfill throughout region: uplifted manholes



# Niigata Prefecture Estimates ¥1,500 bn (US\$12.8 bn) in Damage Costs

	2007 Earthquake Projected Damage Costs	2004 Earthquake Estimated Damage Costs
Buildings	¥200 billion	¥700 billion
Infrastructure	¥70 billion	¥1,200 billion
Businesses and Factories	¥300 billion	¥300 billion
Agriculture, Forestry, and Fishing	¥ 40 billion	¥400 billion
Utilities	¥10 billion	¥100 billion
Other	¥880 billion* (NPP, Tourism)	¥300 billion
<b>TOTAL</b>	<b>¥1,500 billion</b>	<b>¥3,000 billion</b>



Turning disaster into knowledge

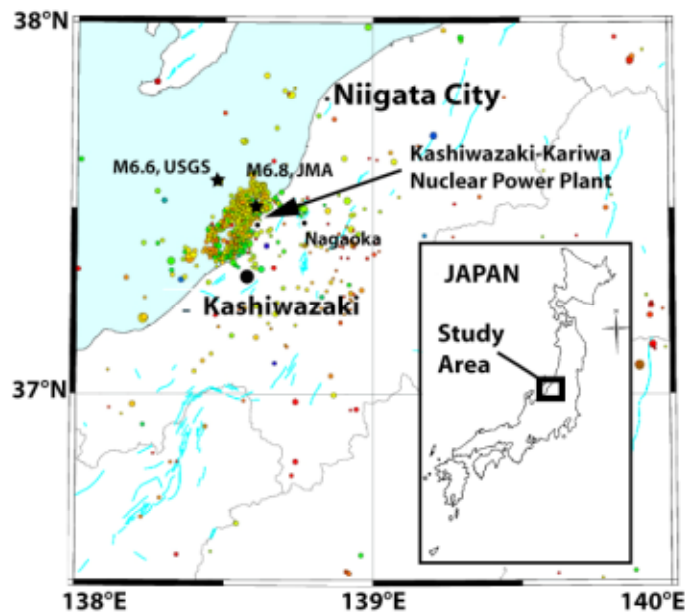
\*Equals US\$7.5 bn

(Source: Policy Division, Governor's Policy Bureau, Niigata Prefecture, July 23, 2007)





# GEER Response to the Niigata Chuetsu-Oki Earthquake of July 16, 2007



Report at:

<http://pubs.usgs.gov/of/2007/1365/>

GEER web report and Google Earth Map is at:

[http://gees.usc.edu/GEER/2007Japan/jp\\_2007\\_title.htm](http://gees.usc.edu/GEER/2007Japan/jp_2007_title.htm)



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