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The 2011 Tohoku Earthquake and Dams

ICOLD 89th Annual Meeting in Lucerne
June 1, 2011

Japan Commission on Large Dams
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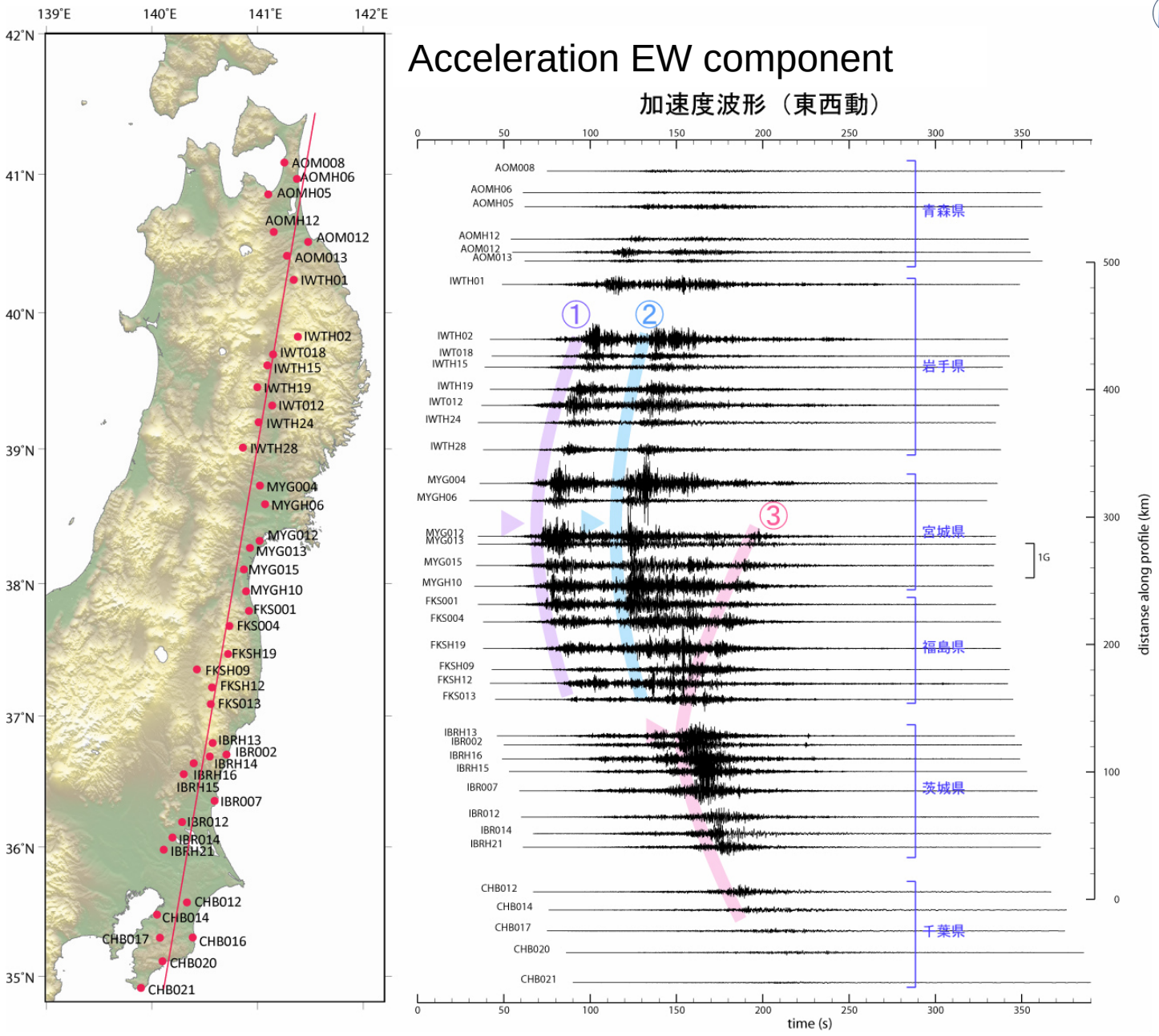
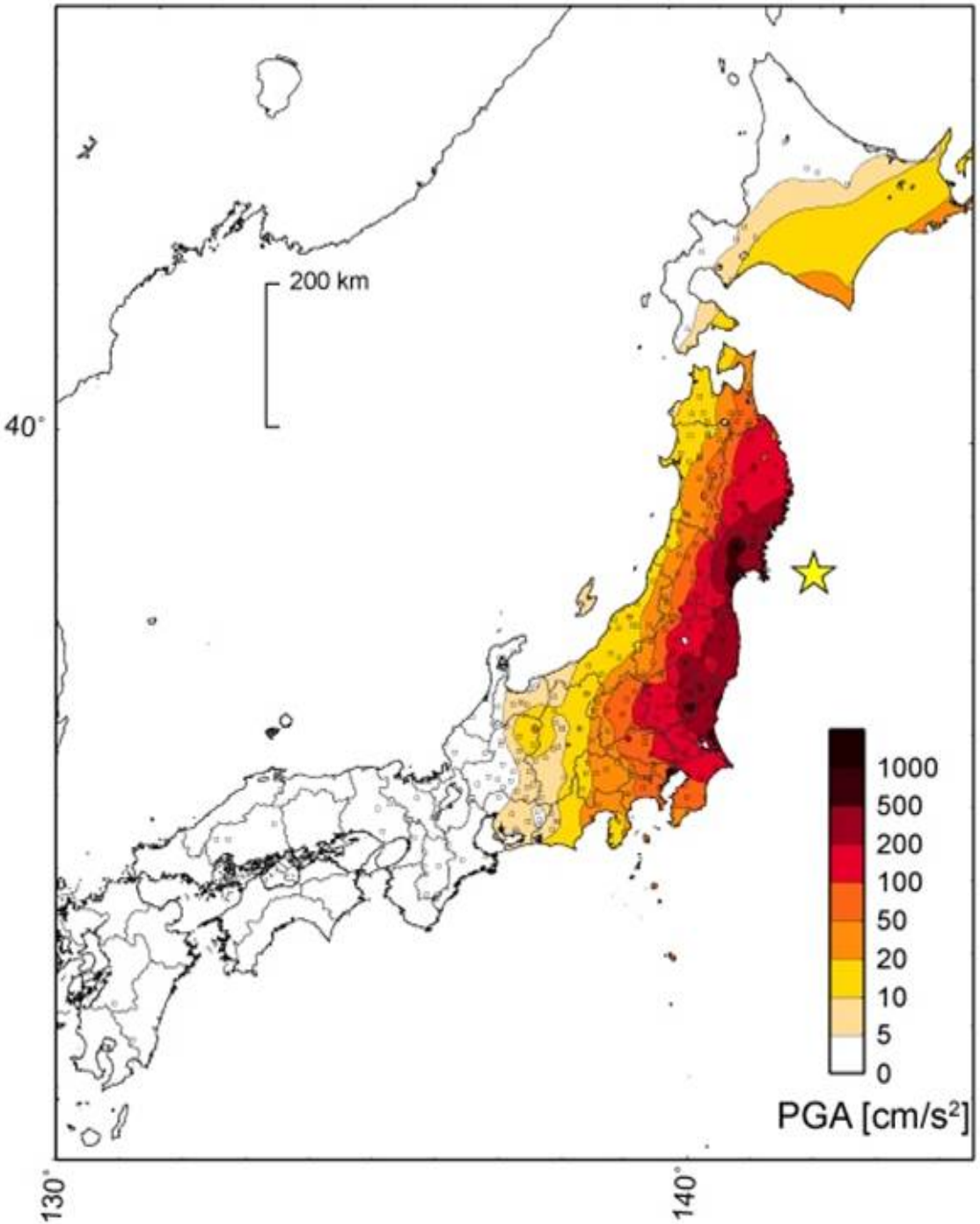
Acceleration EW component



ERI (Earthquake Research Institute, Univ. of Tokyo)



PGA distribution
by ERI

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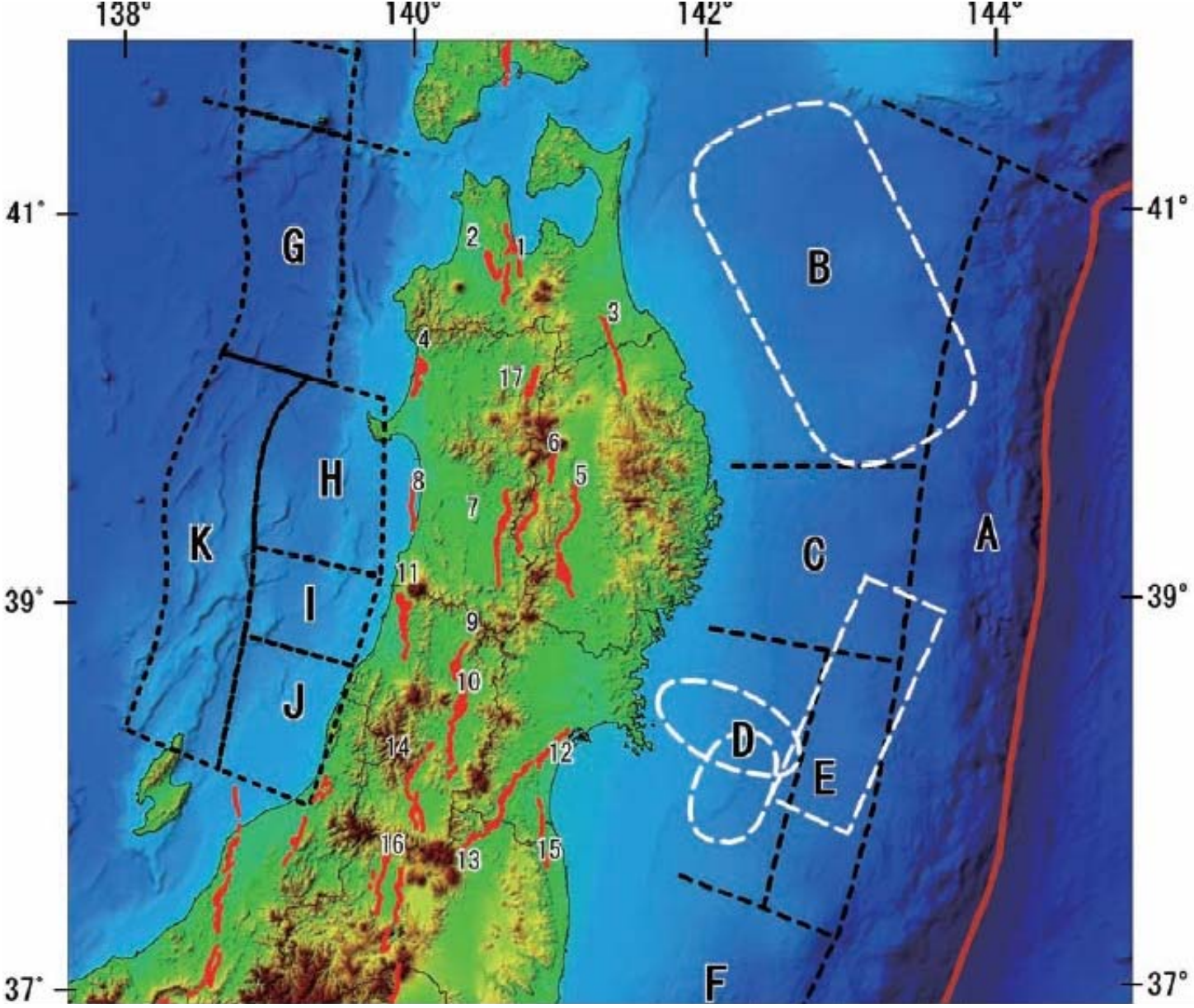
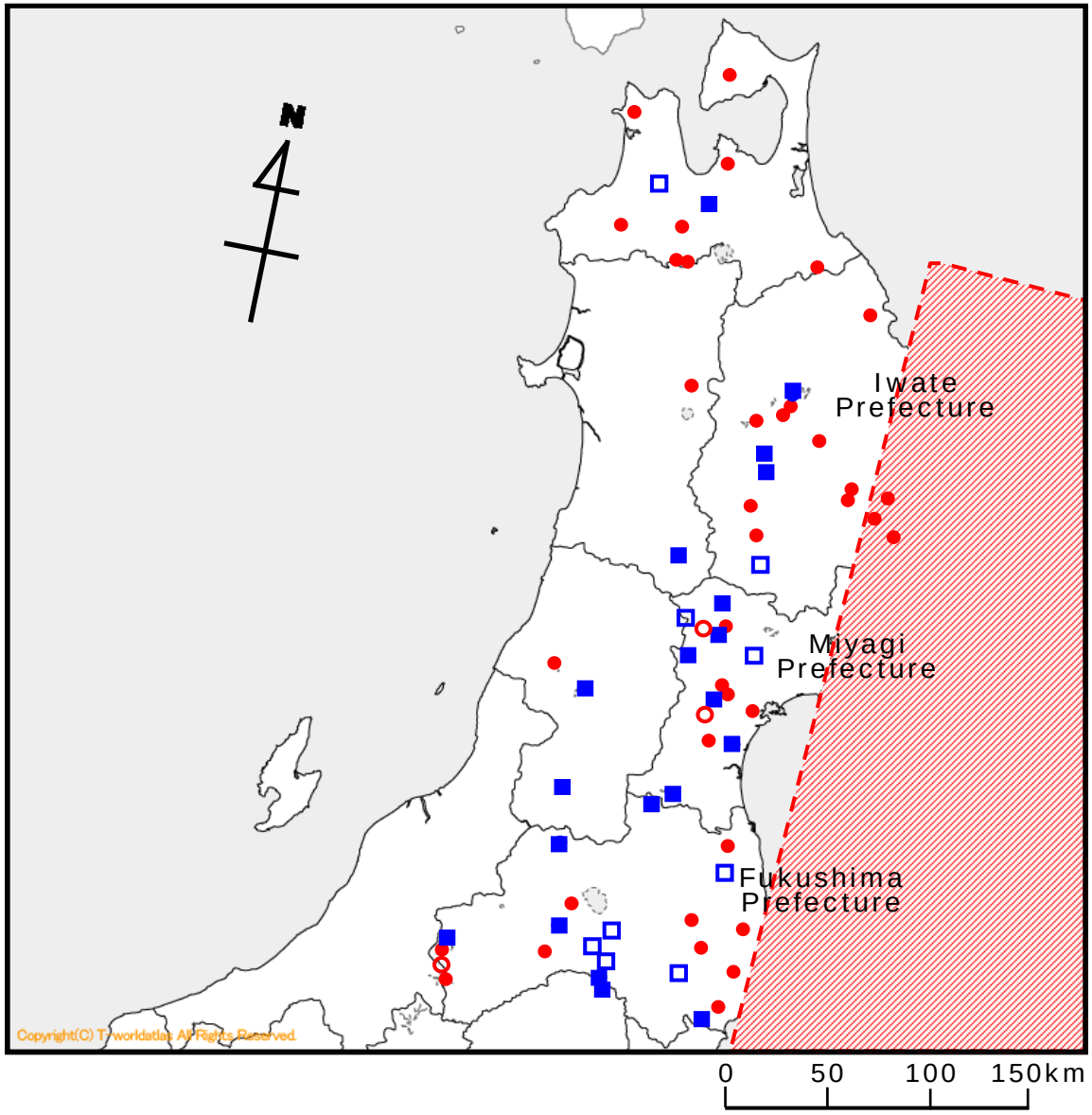
JDEC



Headquarters for Earthquake Research Promotion

D: Occurrence probability more than 99% in 30 years M=8.0 at most



Faulted area and dams

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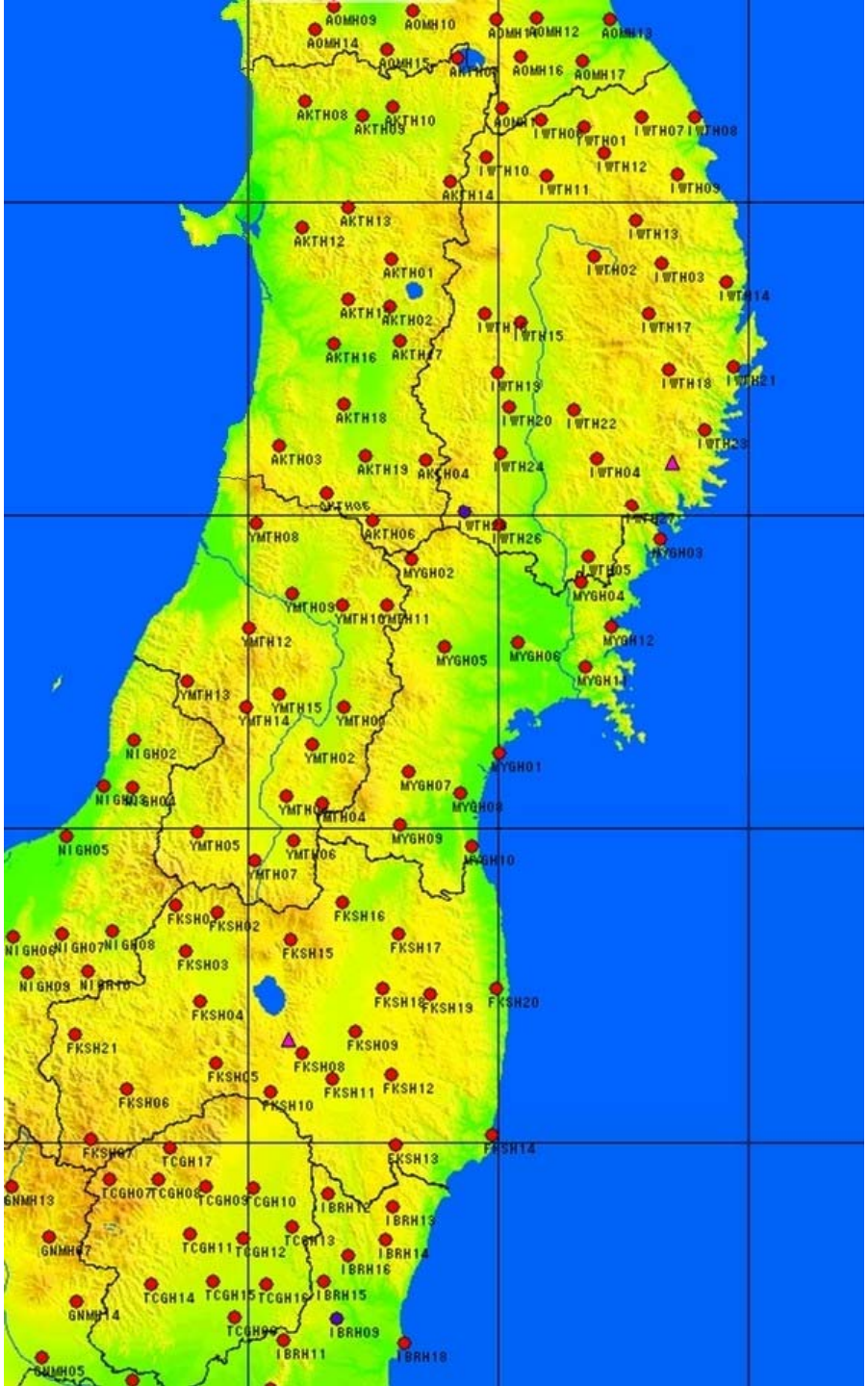
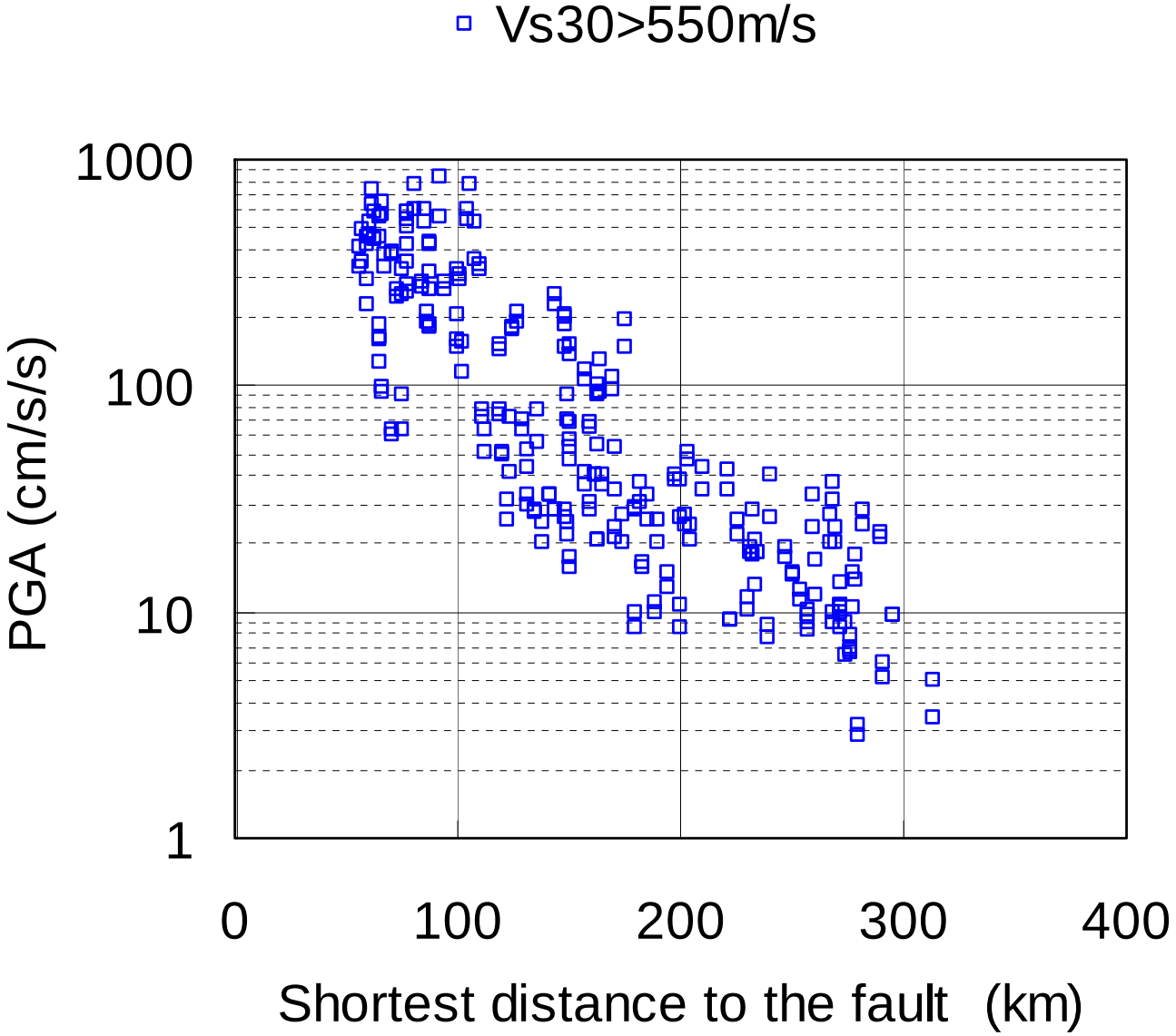
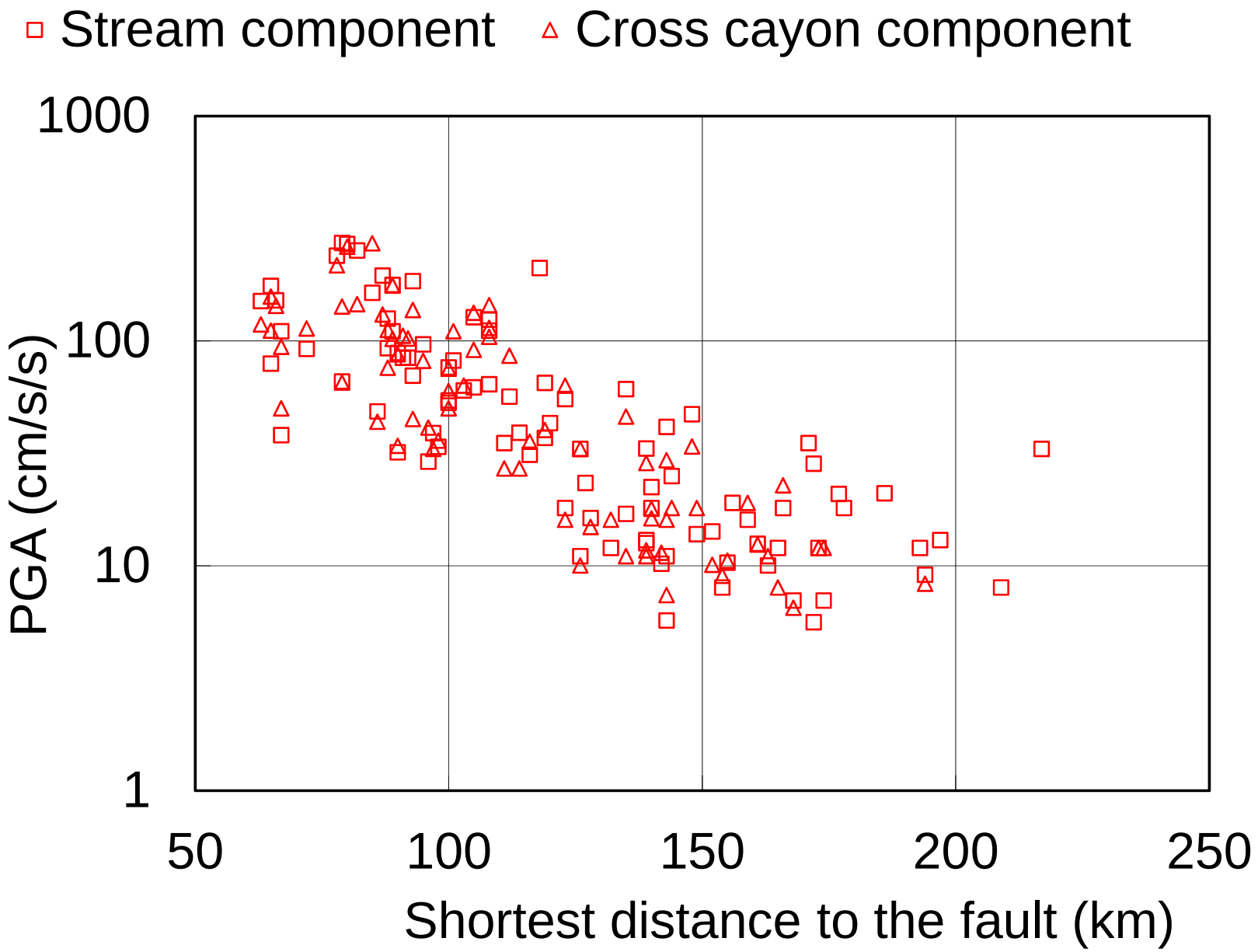
Location of Kik-net stations
NIED



PGA attenuation (Horizontal) Kik-net (NIED)



PGA at dam foundations (Horizontal)



Inspection of dams after the main shock

Jurisdiction (Number of dams)	Ower	Number of dams	
		inspected	suffered unusual behavior* or damage (failure)
Ministry of Land, Infrastructure, Transport and Tourism (150)	Central Gov.	46	11
	Local Gov.	104	8
Ministry of Agriculture, Forestry and Fisheries (172)	Central Gov.	51	4
	Local Gov.	121	23(1**)
Electric Power Companies (69)	Hokkaido	8	0
	Tohoku	24	0
	Tokyo	29	1
	J-Power	7	1
	Kansai	1	0
Total		391	48(1)

*unusaul behavior: small increase of leakage & uplift, nominal settlement and others

**The failed one was on a non regulated river.

Takou Dam Concrete Gravity　H=77m　completed in 2006

Takou Dam: The wall of gate house was cracked.

Inside the house, bolts were cut off and the hoist was displaced.

Minamikawa Dam

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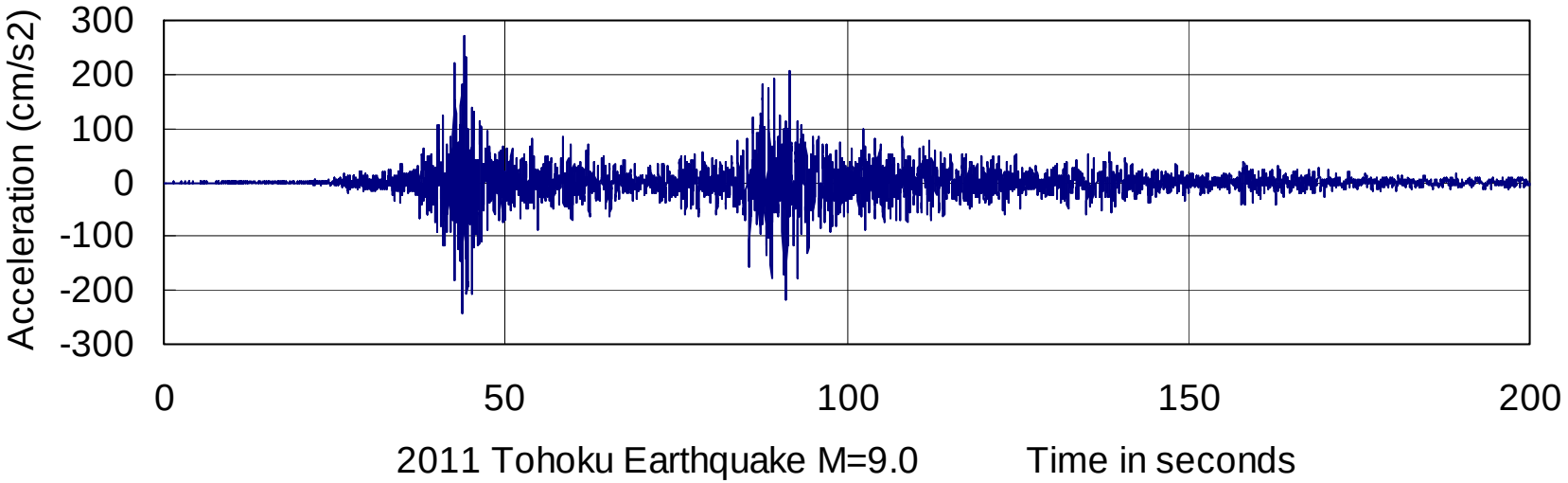
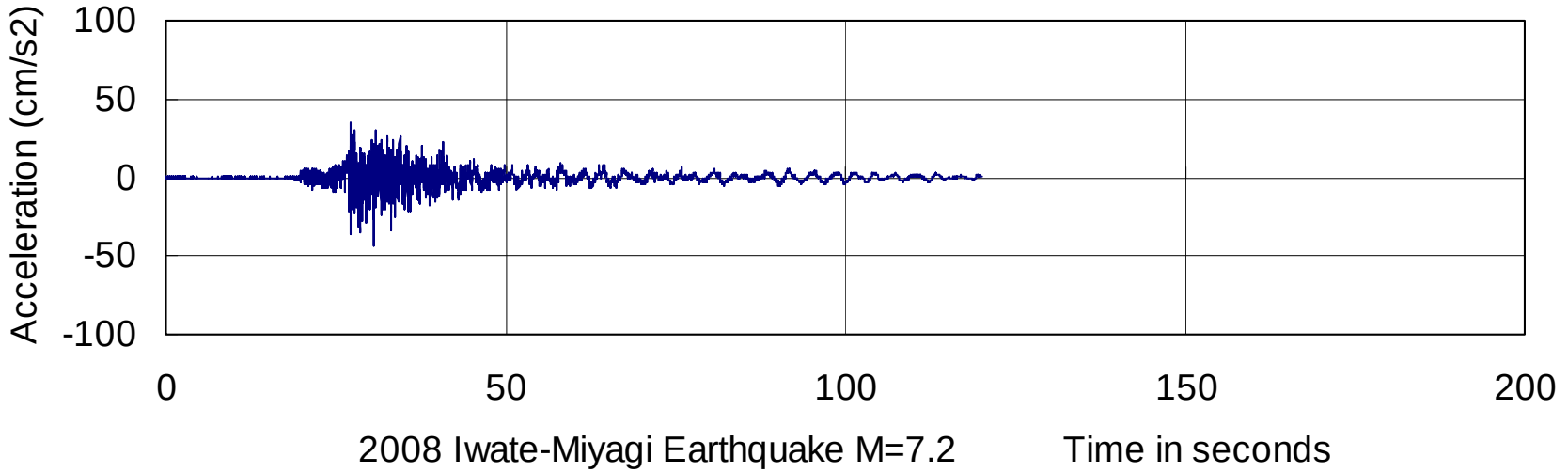
Main dam: concrete gravity

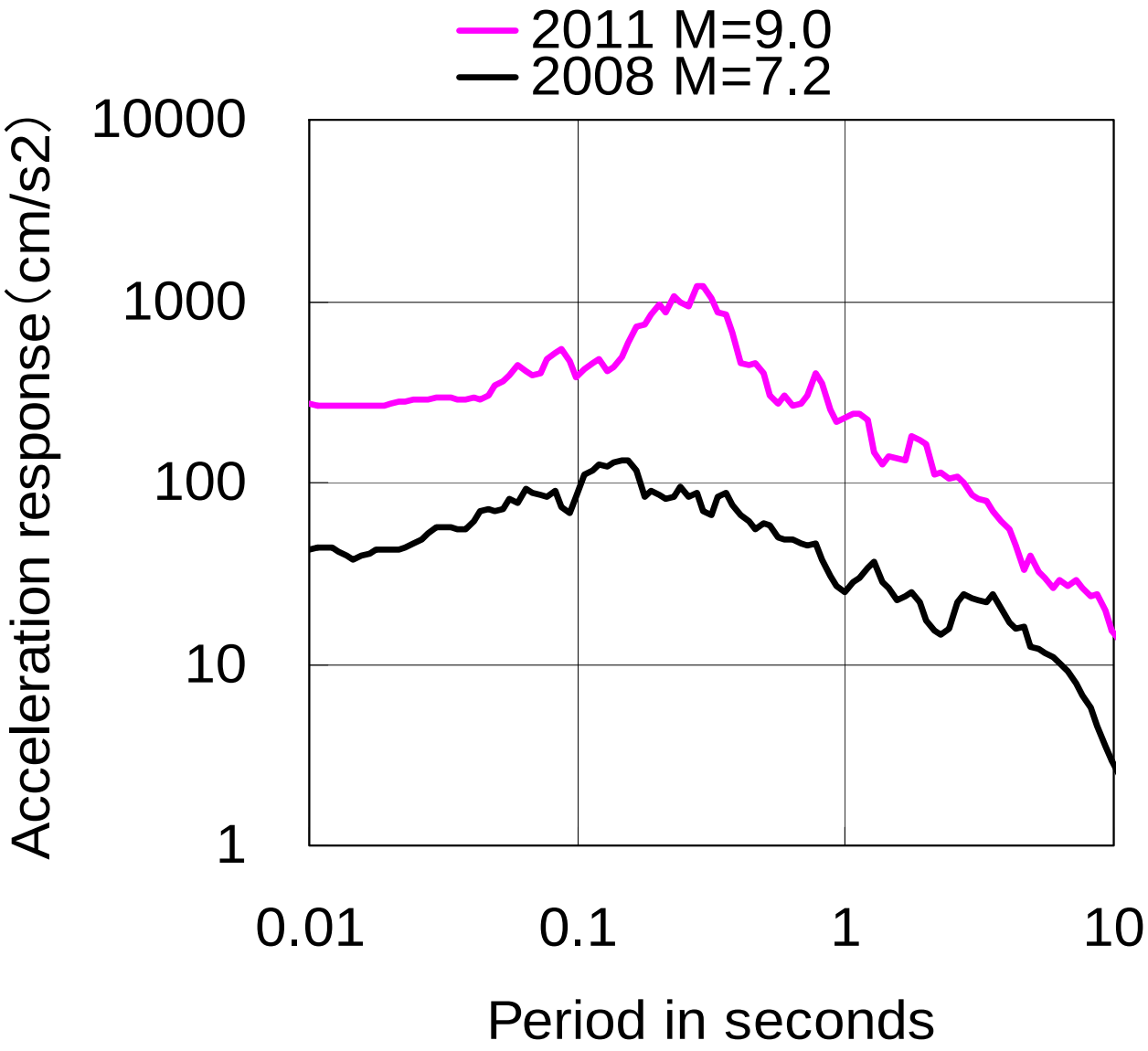
Saddle dam: asphalt concrete face rockfill

Foundation ground motions at Minamikawa Dam

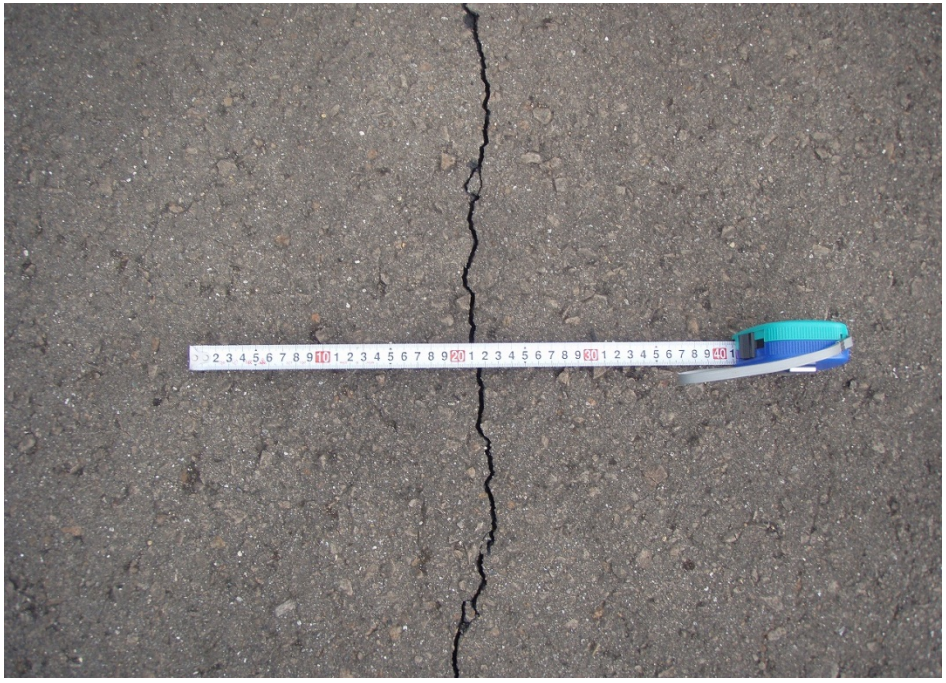




Acceleration response spectrum



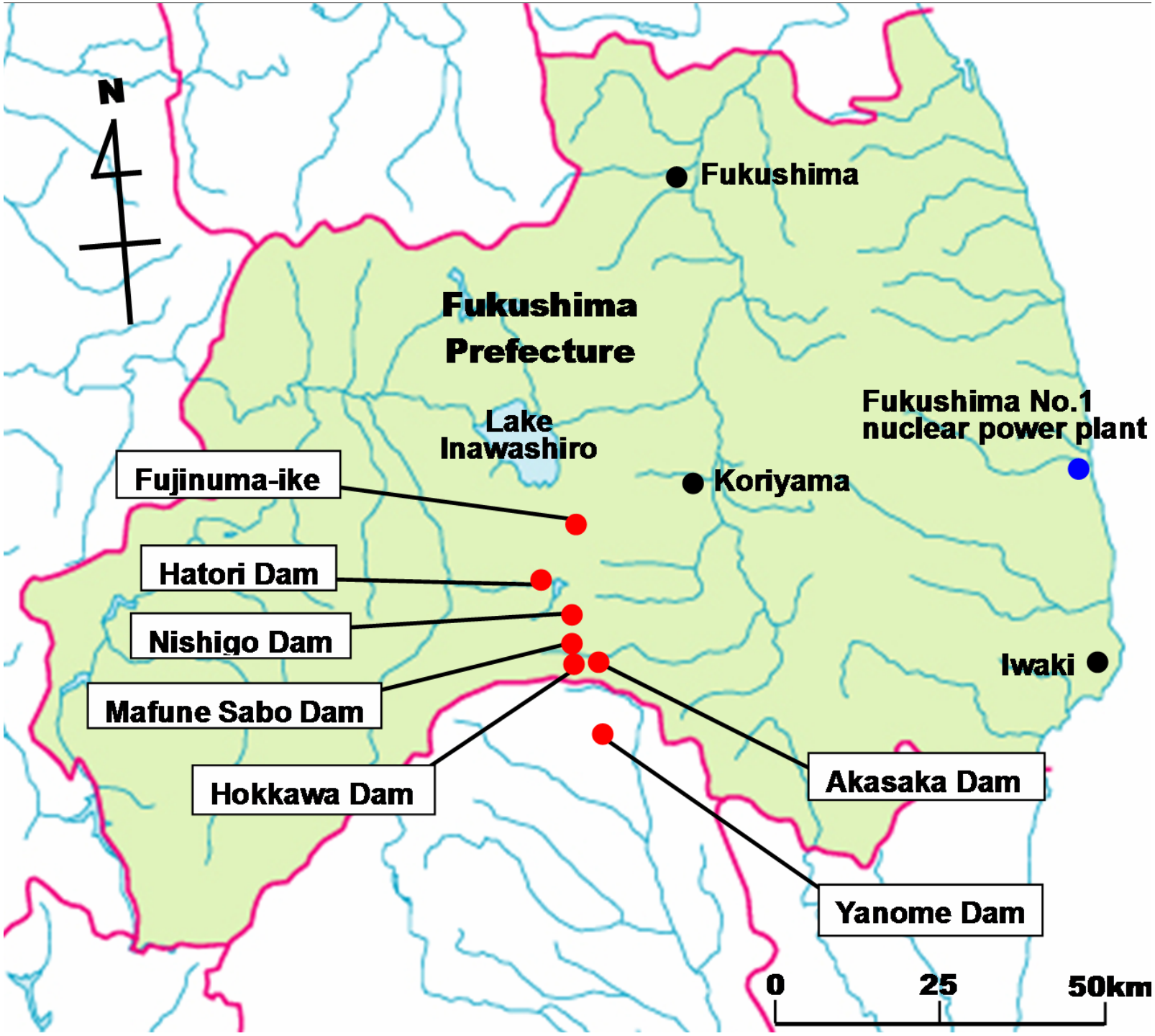
Cracking on the asphaltic concrete face --the width is 3 mm.



Cracking on the asphalt concrete face Numappara Dam JCOLD

H=38m PGA(fondation)=0.21g PGA (crest)=0.35g

Koromogawa No. 1 Dam
2011 Tohoku Earthquake


N
Fukushima
Fukushima
Prefecture
Lake
Inawashiro
Fukushima No.1
nuclear power plant
Koriyama
Iwaki
Fujinuma-ike
Hatori Dam
Nishigo Dam
Mafune Sabo Dam
Hokkawa Dam
Akasaka Dam
Yanome Dam
0
25
50km

Nishigo Dam H=32.5m completed in 1955
March 11, 2011 on the day

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Nishigo Dam April 11, 2011
one month after the event, drawdown of water

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Fujinuma-ike Nov. 2006

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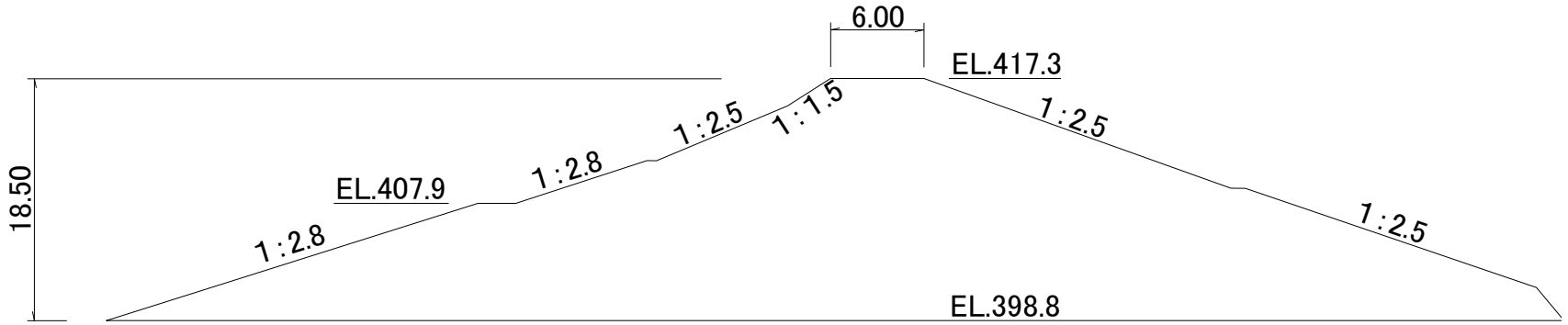
Fujinuma-ike after breach

Fujinuma-ike was breached shortly after the earthquake. It was an eathfill type embankment with the height of 18.5 m and the length of 133 m. The reservoir capacity was 1.5 million m^3.



Looking towards right abutment

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Right abutment

Fujinuma-ike saddle embankment

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http://www.nilim.go.jp/lab/bbg/saigai/h23tohoku/110314sabo.pdf

Conclusions

- Generally dams performed well with minor or moderate damage. They withstood severe ground motion.
- However, one earthfill dam type embankment failed. It was constructed in 1949. Ensuring the safety of not well engineered old structures is our primary concern.
- MCE is a really maximum earthquake?
- What will happen, when the event exceeding MCE would occur?
- PGA’s were not extraordinary large, but the duration of the motion was extraordinary long. The frequency of the ground motion was in the range of natural frequency of dams. The preliminary study suggests that a very long duration of the motion and not a few strong aftershocks rendered more impacts on fill dams than on concrete dams.

JCOLD thanks

- National Research Institute for Earth Science and Disaster Prevention (NIED)
- Earthquake Research Institute, Univ. of Tokyo (ERI)
- Ministry of Land, Infrastructure, Transport and Tourism (MLIT)
- Ministry of Agriculture, Forest and Fishery (MAFF)
- Japan Meteorological Agency (JMA)
- Iwate, Miyagi and Fukushima Prefectures
- Hokkaido, Tohoku, Tokyo, J-Power, Kansai and Hokuriku Electric Power Companies
- National Institute of Land and Infrastructure Management (NILIM)
- Public Works Research Institute (PWRI)
- Japan Water Agency (JMA)
- Japan Society of Dam Engineers (JSDE)
- Japan Dam Engineering Center (JDEC)

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