



Far-Field Ground Motion Characteristic in Bangkok Basin during the Mw 7.7, 28 March 2025 Earthquake

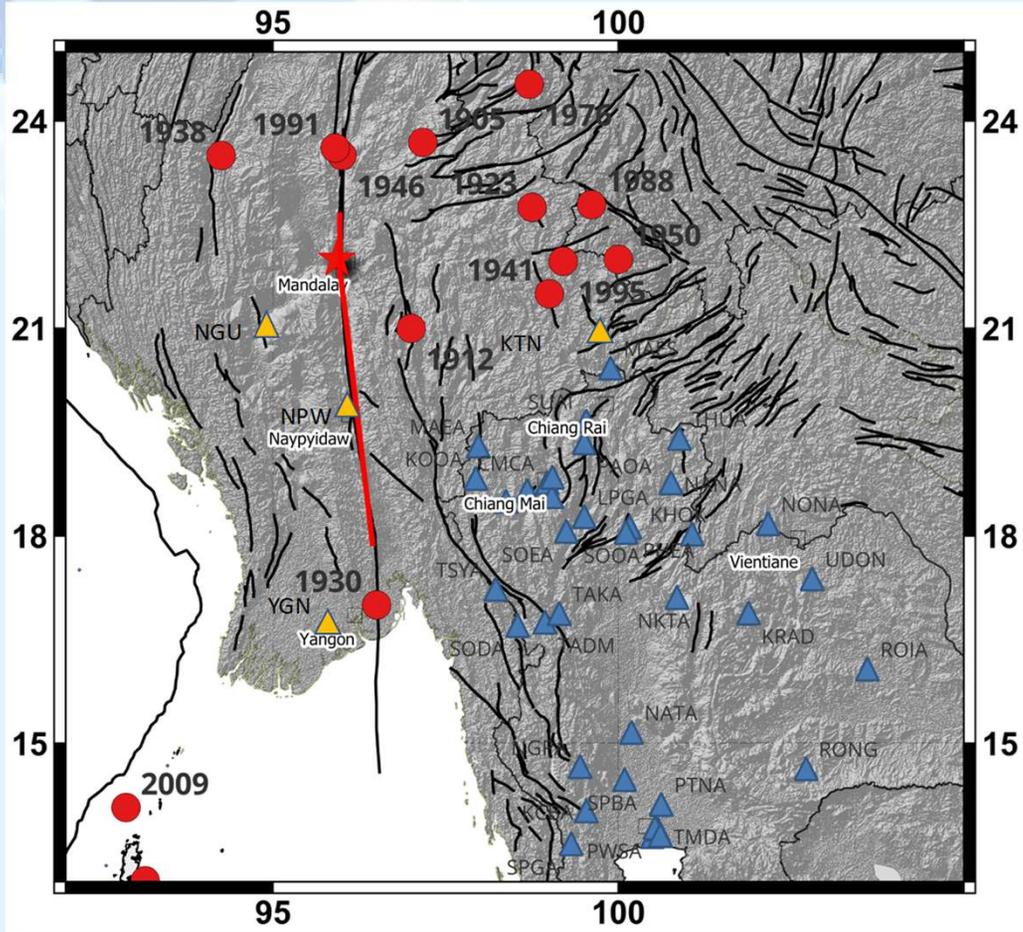
Bangkok skyline in April 2025



Assoc. Prof. Dr. Teraphan Ornthamarath, M. EERI
Department of Civil & Environmental Engineering, Mahidol University
teraphan.orn@mahidol.ac.th



Strong Motion Sensors in Thailand



No.	Station Code	Lat	Long	Vs30 (m/s)	Soil Type	Test Method
1	BKKA	13.664	100.6102	139	E	AM
2	BKSI	13.72633	100.5598	200	E	AM
3	CHTO	18.8141	98.9443	767	B	MASW
4	CMCA	18.77122	98.96936	332	D	MASW
5	KCBA	14.02233	99.536	368	C	MASW
6	KHOK	18.02648	101.0688	501	C	MASW
7	KMUA	13.6512	100.4942	162	E	AM
8	KOOA	18.83089	97.93572	622	C	MASW
9	LPGA	18.27819	99.50656	297	D	Global
10	MAEC	18.49693	98.37328	434	C	Global
11	MAES	20.4276	99.8865	330	D	MASW
12	MHIT	19.3148	97.9632	379	C	MASW
13	NANA	18.7672	100.7633	279	D	MASW
14	NGPA	14.66242	99.44678	387	C	MASW
15	PAOA	19.34713	99.50677	440	C	Vs30
16	PHEA	18.1272	100.1656	286	D	MASW
17	PTNA	14.11611	100.6203	161	E	AM
18	PWSA	13.77753	100.5295	139	E	AM
19	SANA	18.8491	99.0454	345	D	AM
20	SOEA	18.06591	99.24645	290	D	Global
21	SUAI	19.66101	99.53454	395	C	MASW
22	THUA	19.40847	100.8825	454	C	MASW
23	TSYA	17.22752	98.22557	379	C	MASW
24	KTN	21.2857	99.5898	451	C	Global
25	NGU	21.20572	94.91662	384	C	Global
26	NPW	19.7785	96.1376	360	C	Global
27	YGN	16.8648	96.1534	243	D	Global

- There is no Mw > 7 in central segment of Sagaing fault since 1902
- In total, there are 23 recorded strong motion in Thailand



1930 Bago earthquake Felt Intensity in Bangkok

V. Strong

King Rama VII

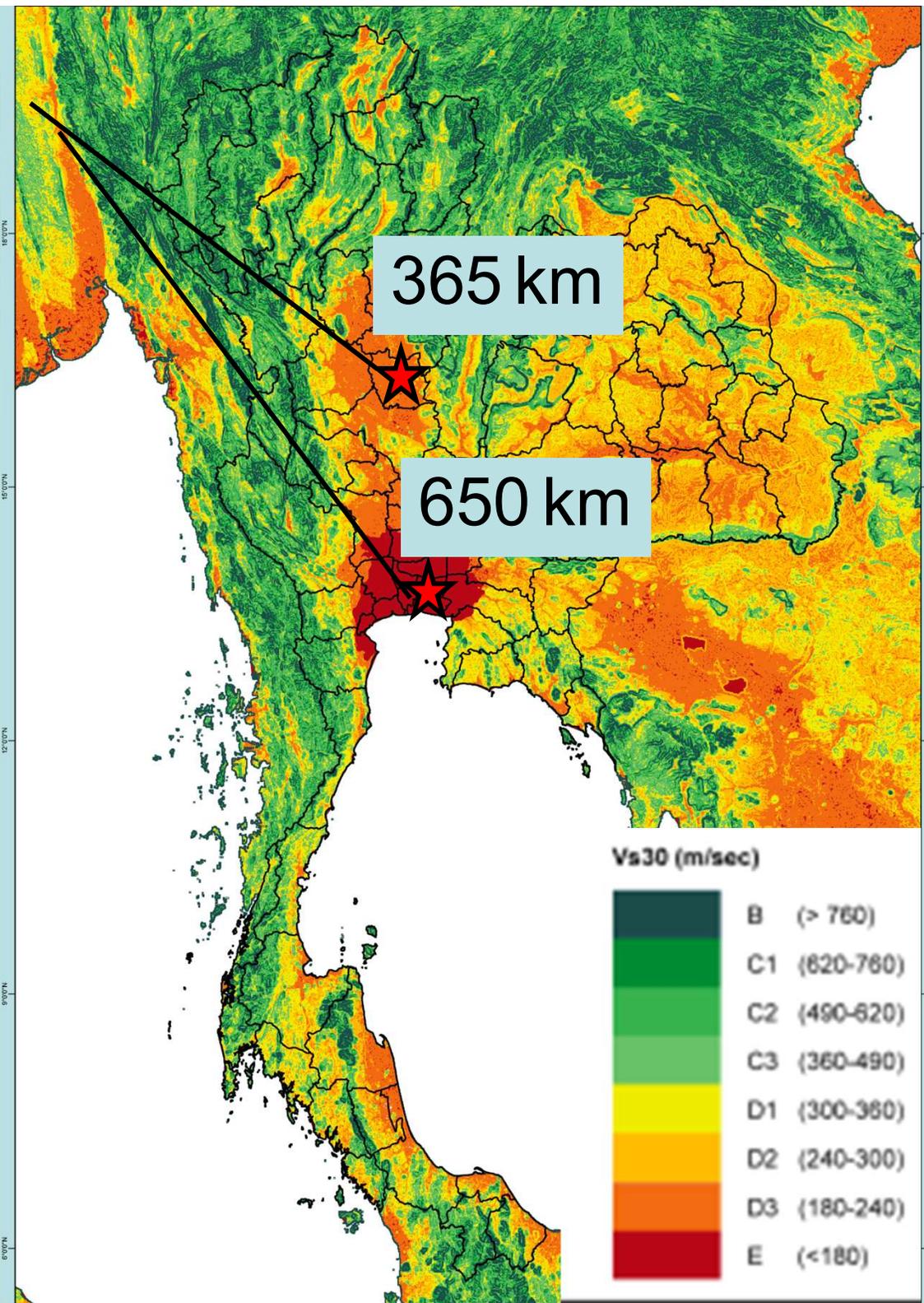
MMI V to PGA 0.04g -0.07g

Woden et al. (2012)

1930, 5 May, 13 45 58 (GMT)
Pegu

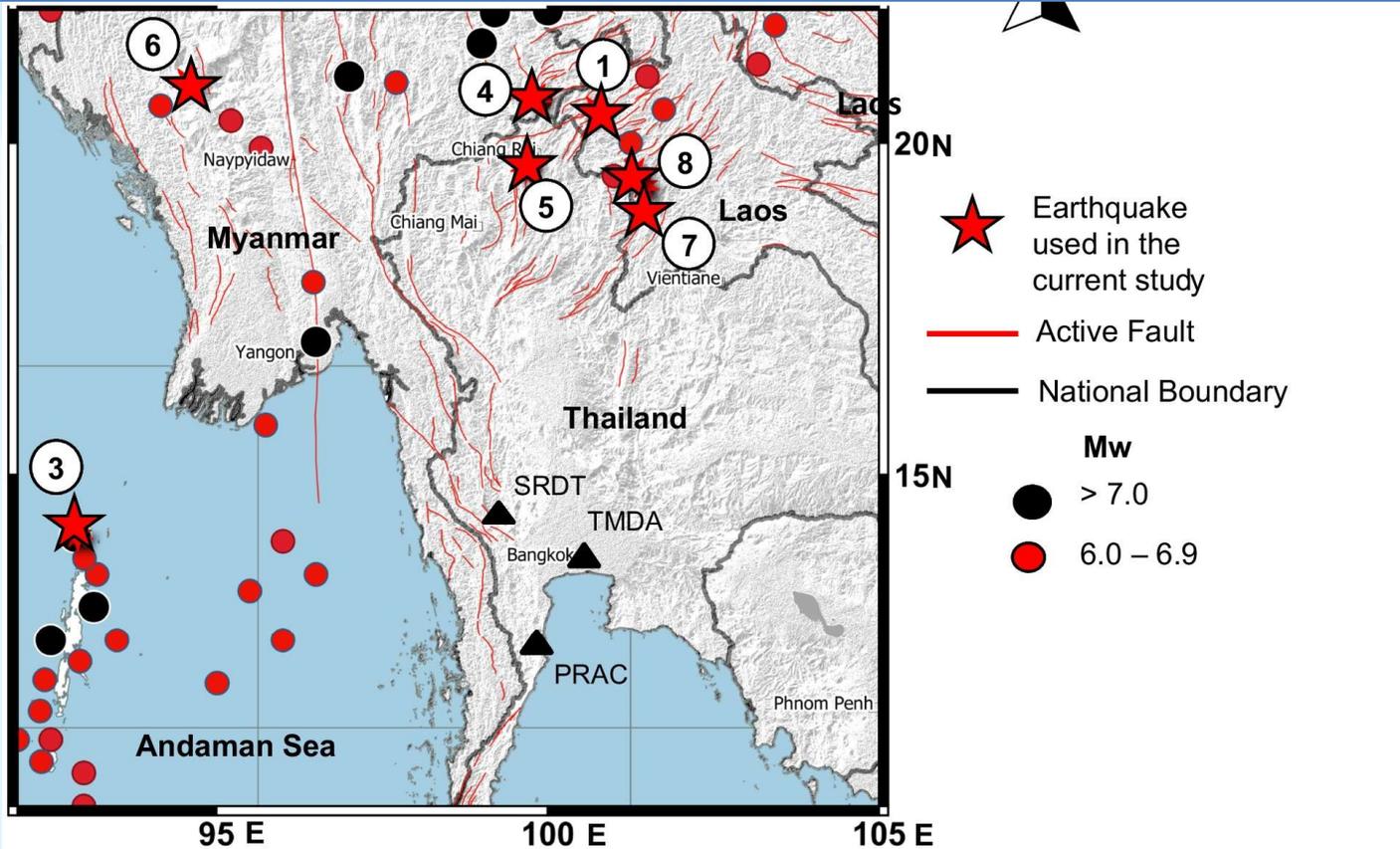
In Bangkok itself though the damage was trivial, consisting as it did of only a few minor cracks in six- and seven-storeyed buildings, the earthquake caused considerable alarm and people ran from their houses into the streets. Lamps and fans were set in motion, unlatched doors moved to and fro, while unbraked stationary motor cars were seen to move; water in tanks was disturbed, the masts of the wireless station swayed distinctly, electrical installations were short-circuited while some clocks with heavy pendulums stopped. The duration is stated to have been about one minute and the direction from north-west to south-east.

Source: Nutalaya P, Sodsri S, Arnold EP (1985) SEASEE Series on Seismology, vol II—Thailand, Southeast Asia Association of Seismology and Earthquake Engineering and U.S. Geological Survey



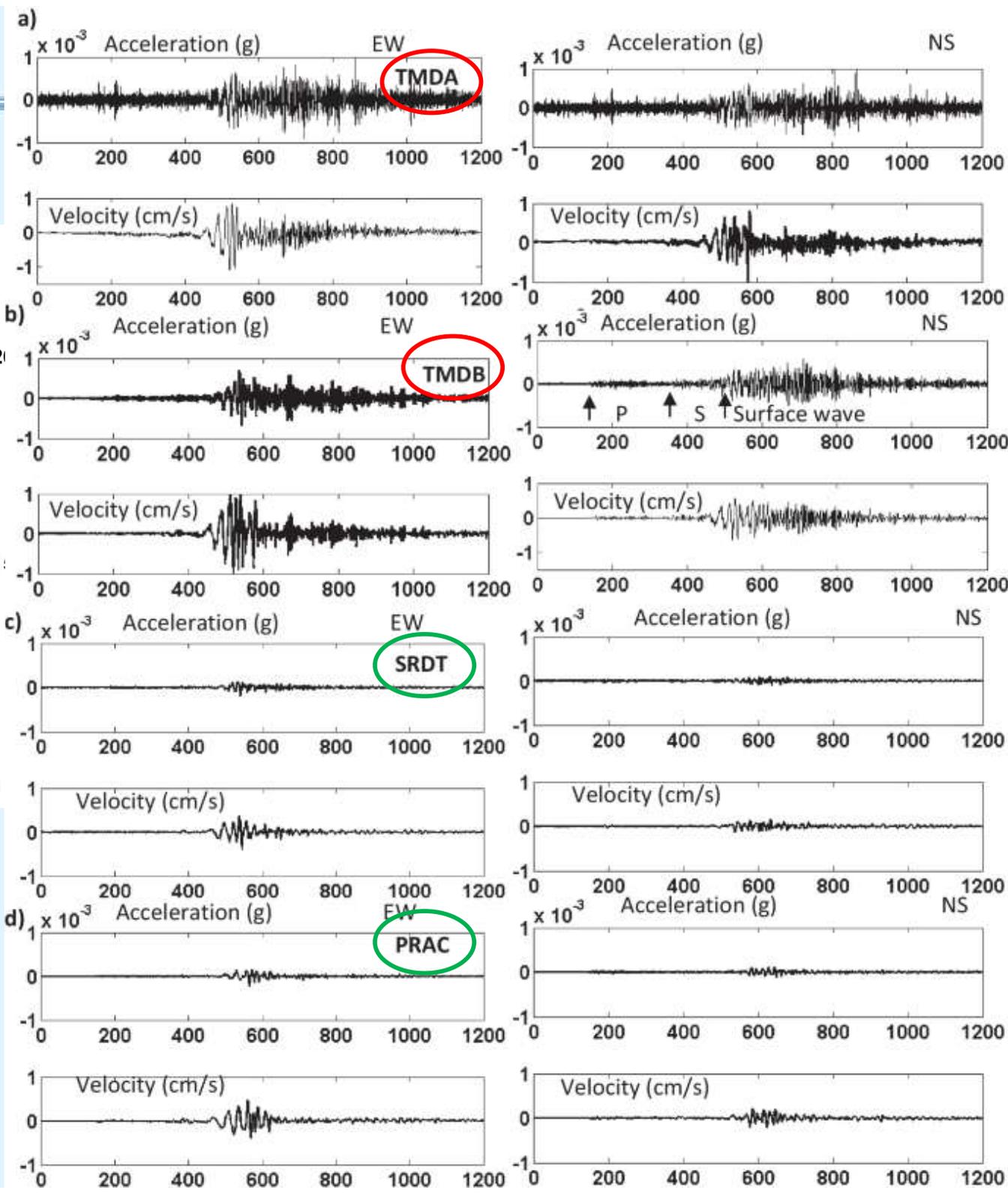
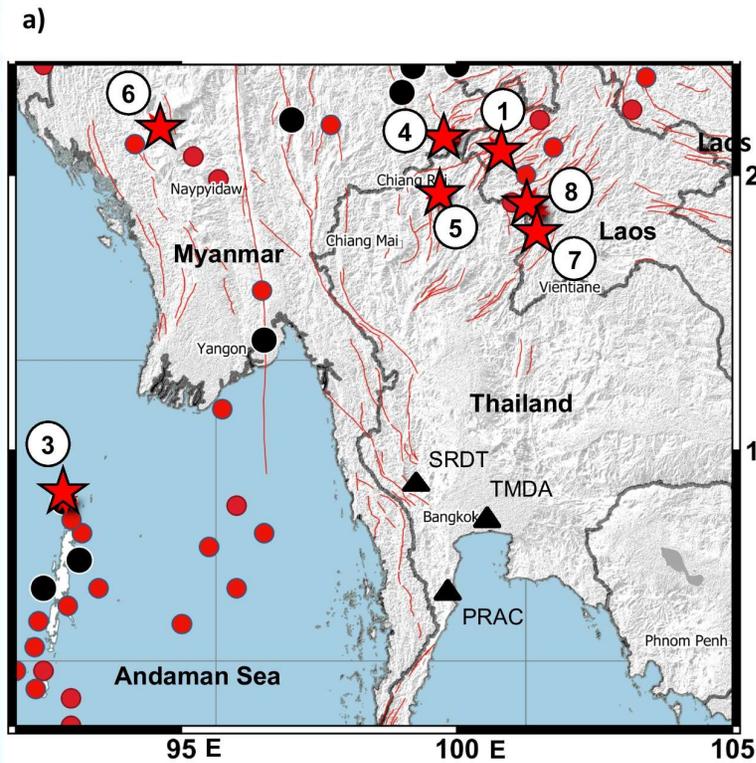


Recent 2007 – 2019 moderate earthquakes Felt in Bangkok

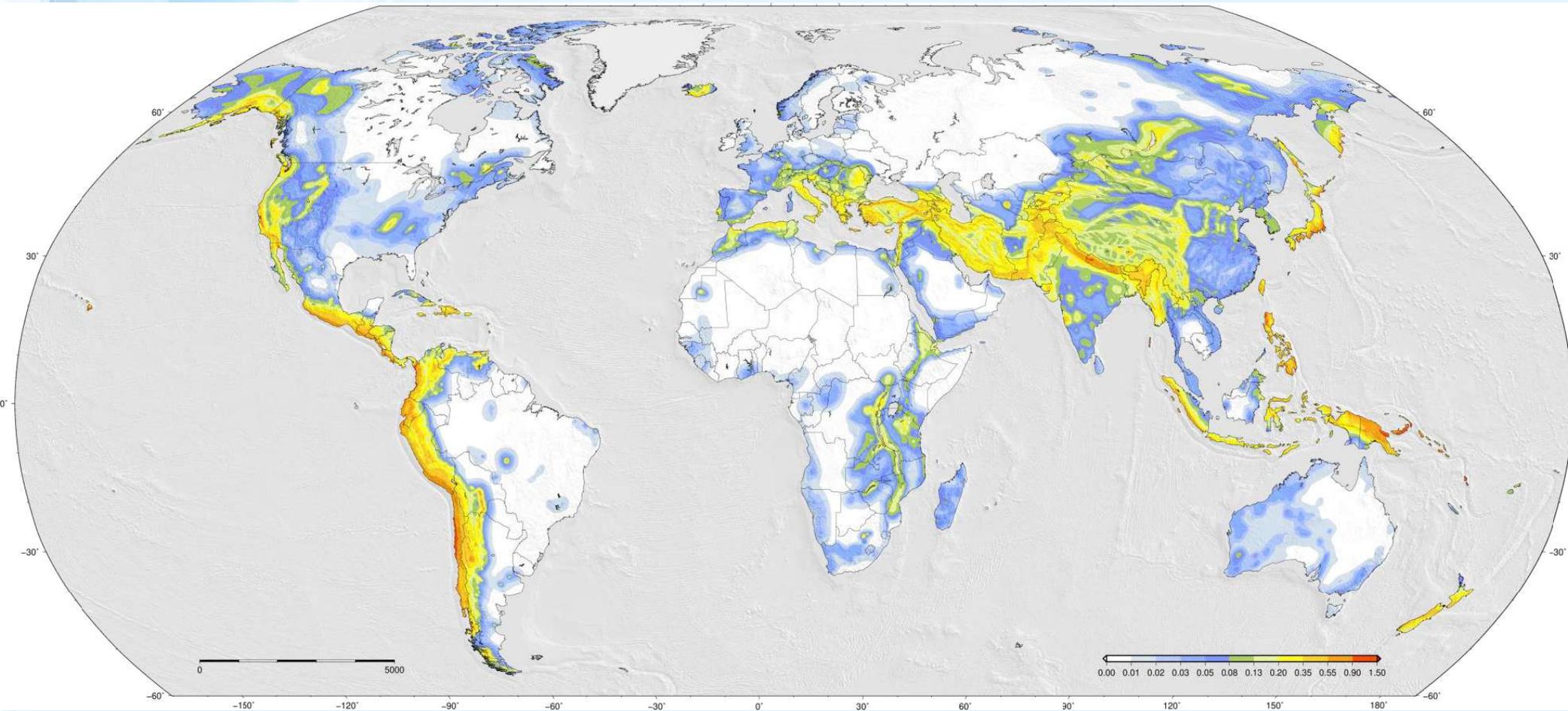


b)

Comparison of Recorded Ground Motion in and outside Bangkok



Global Seismic Hazard Map



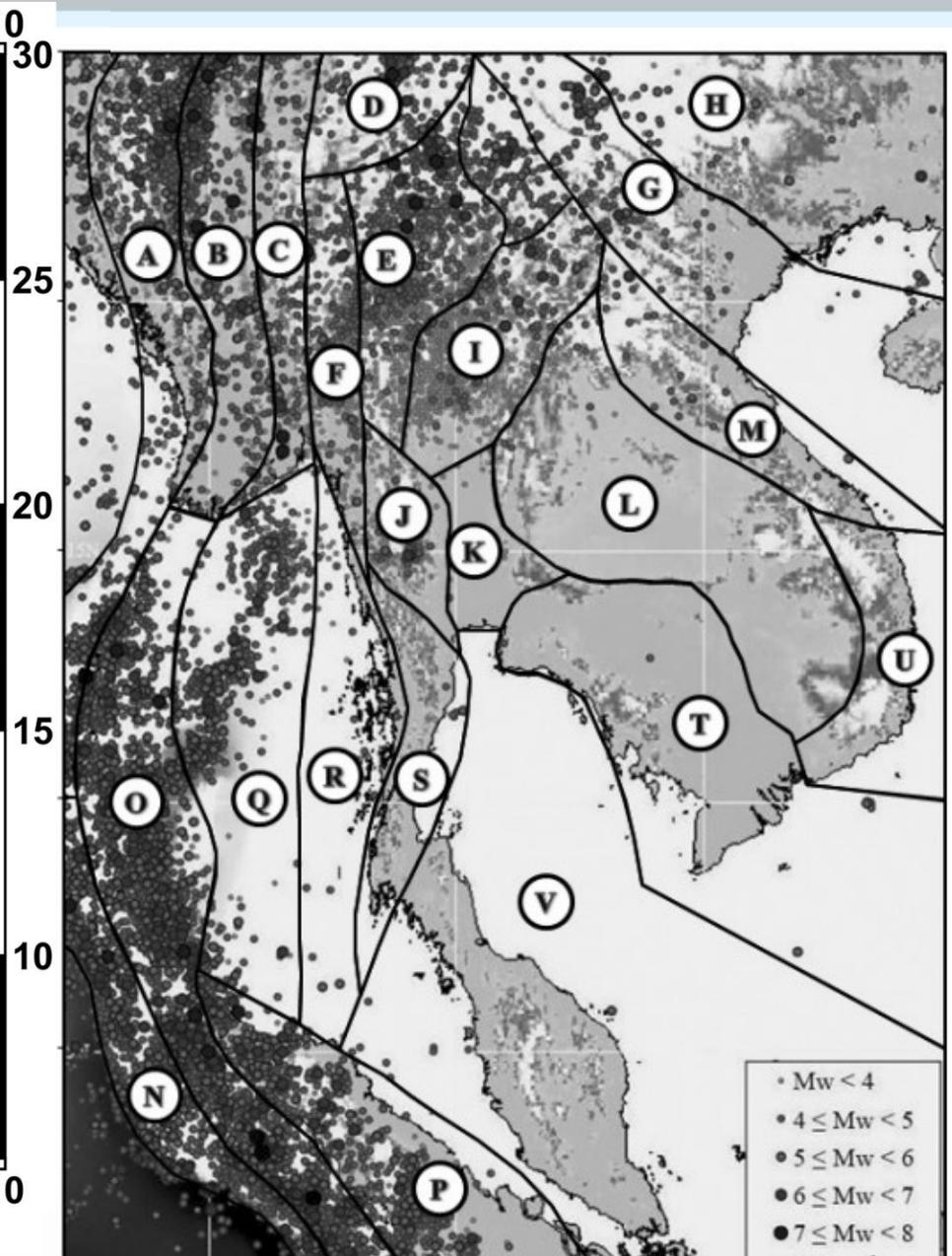
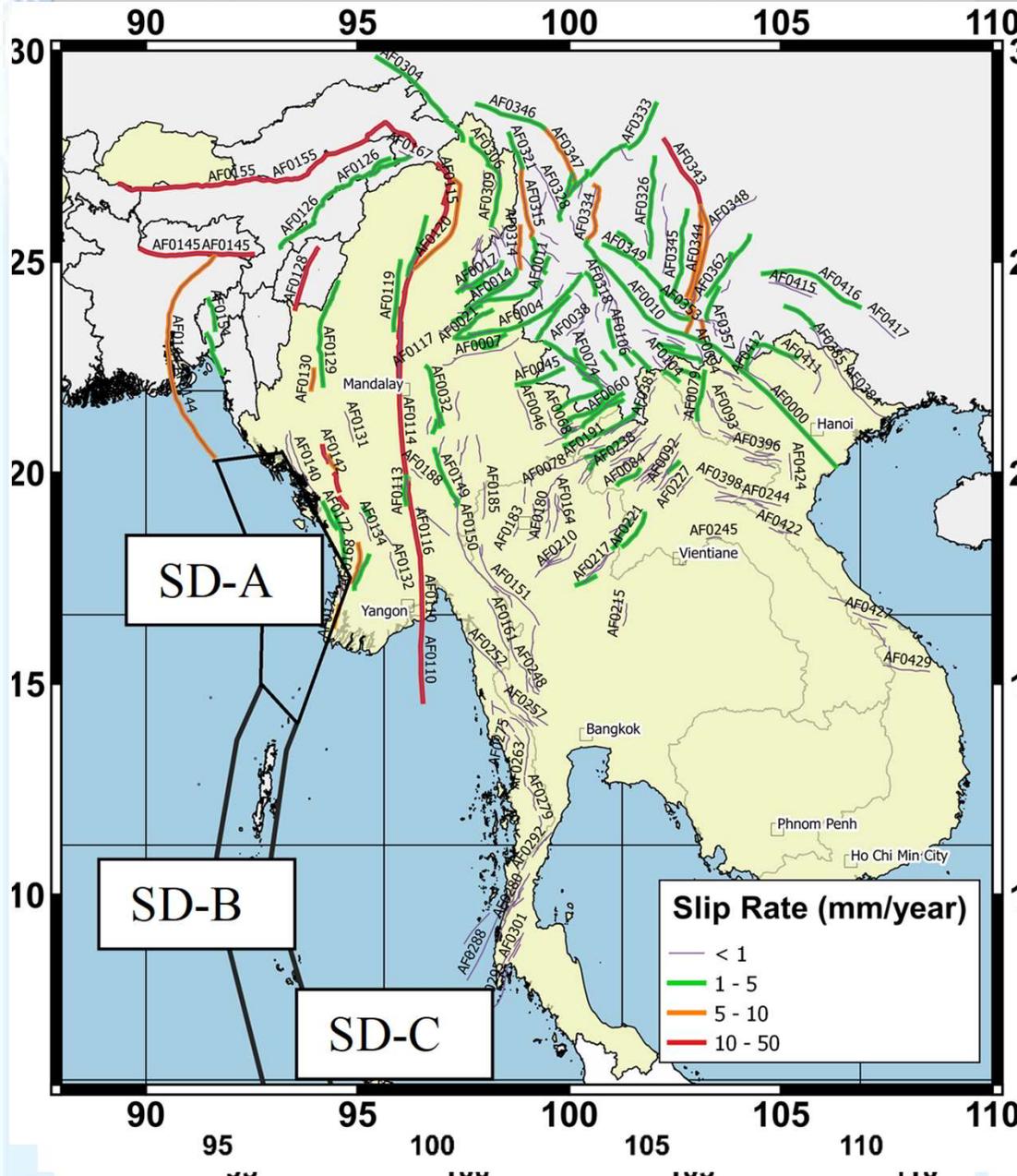
Northern & Western Thailand is considered moderate seismic region with 475-year return period PGA of 0.2g – 0.3g on rock site.

Bangkok is located away from seismic active region and known active fault with 475-year return period PGA of 0.03g on rock site.

Hazard Models for Thailand

Ornthammarath et al. (2011)

Palasri and Ruangrassamee (2010)



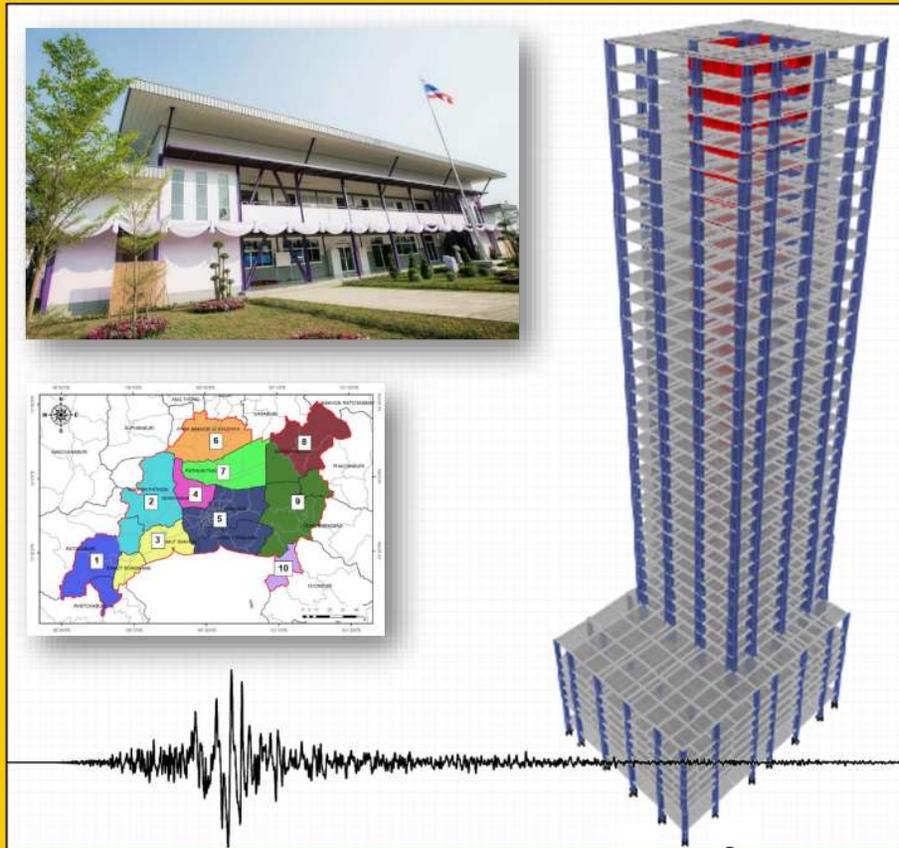
Smooth seismicity + Active fault + Source zone

Source zone

Longitude

มยพ.1301/1302-61

มาตรฐานการออกแบบอาคารต้านทาน
การสั่นสะเทือนของแผ่นดินไหว



National Standard DPT 1302: Seismic Resistant Design of Buildings and Structures

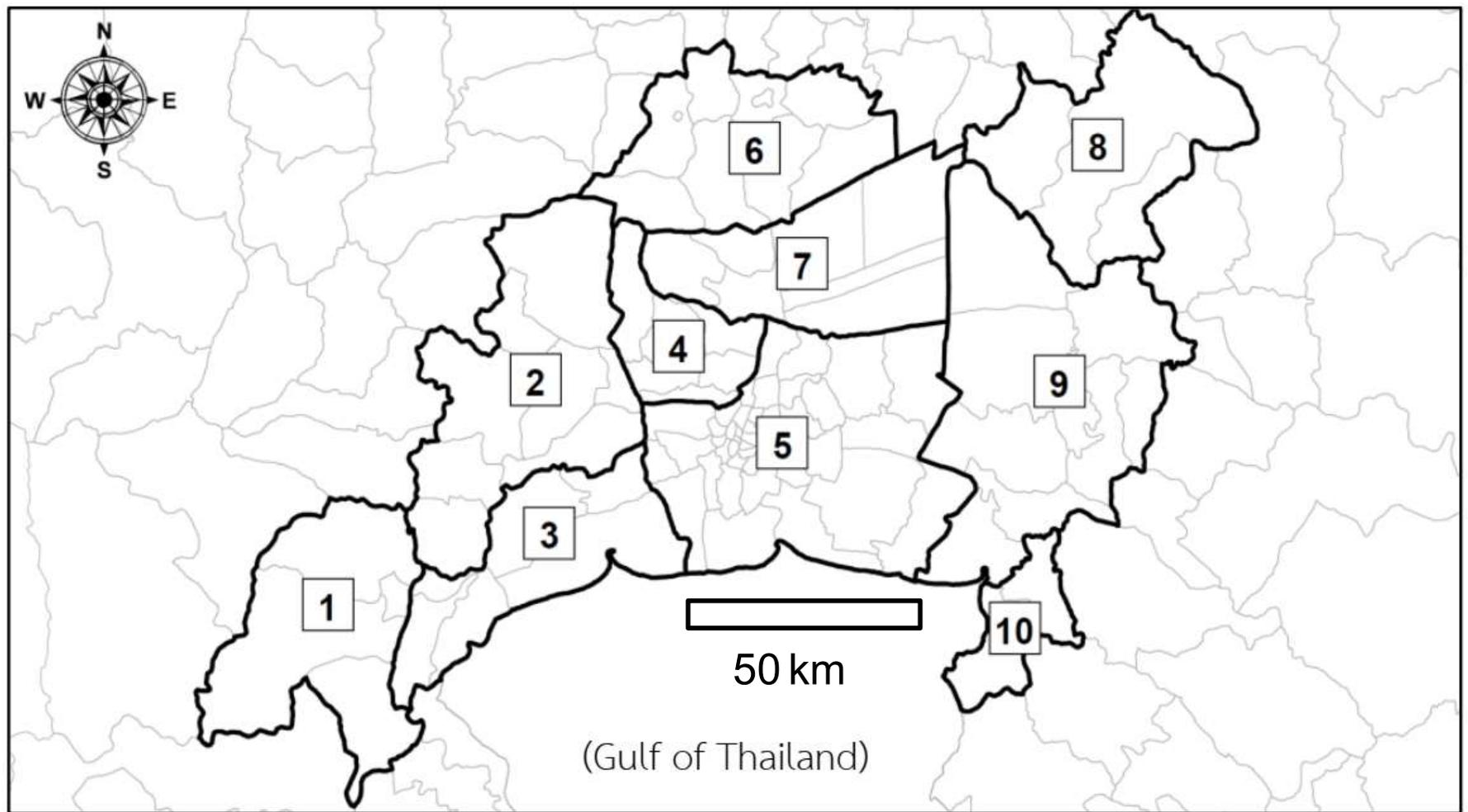
*Issued by Department of Public
Works and Town & Country
Planning, Ministry of Interior
(2018) first issued in 2009*

Model Code: ASCE 7-05

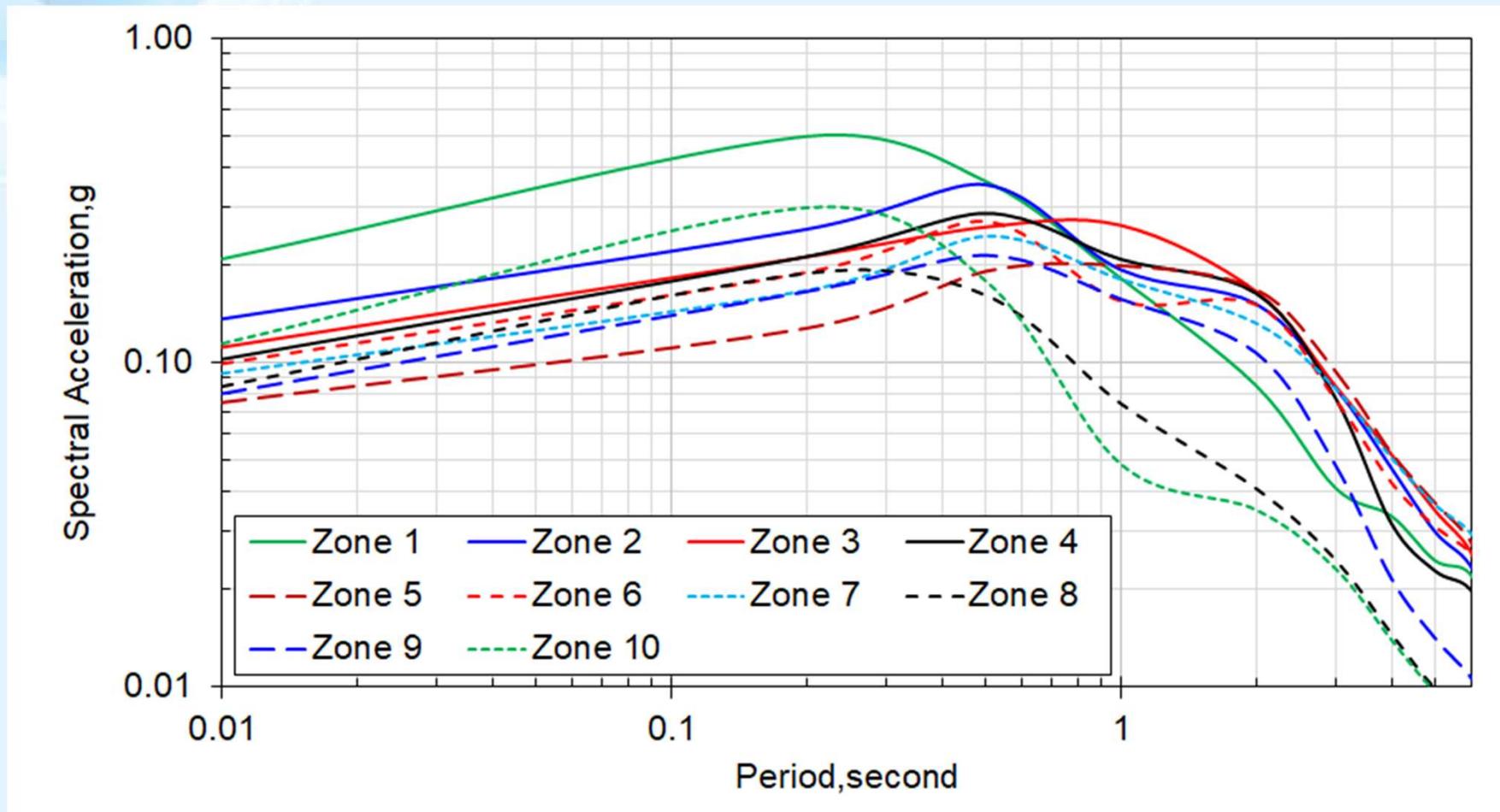
*Require the values of SA at 0.2 sec
and 1.0 sec with 2 % probability of
exceedance in 50 yr (2475-year
return period) for defining
Maximum Considered Earthquake
(MCE) ground motion*



กรมโยธาธิการและผังเมือง
กระทรวงมหาดไทย
พ.ศ. 2561

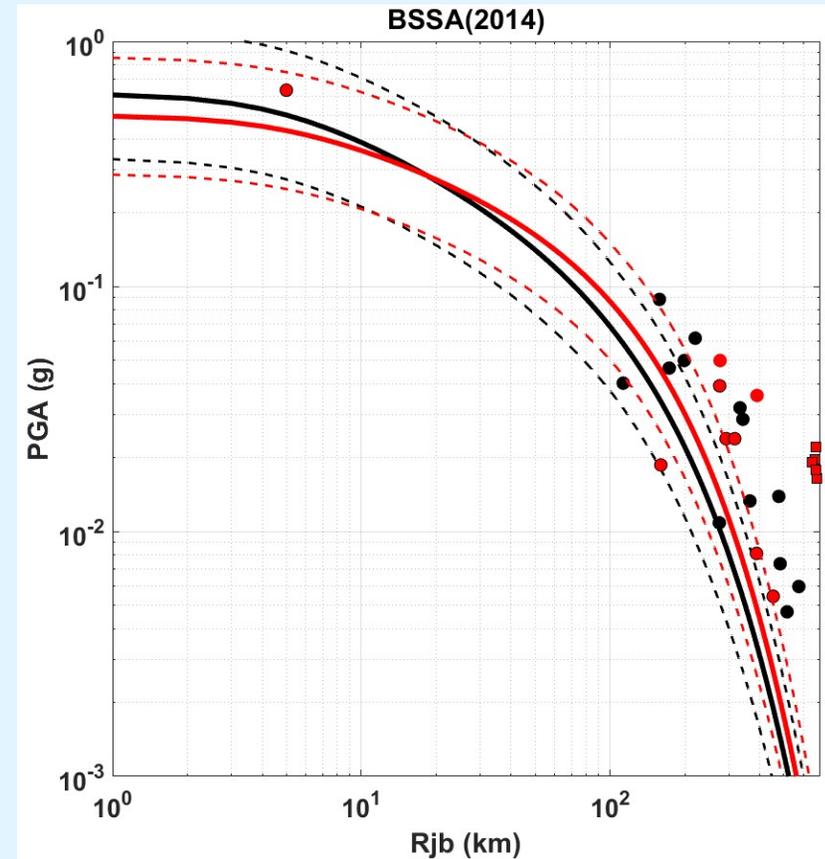
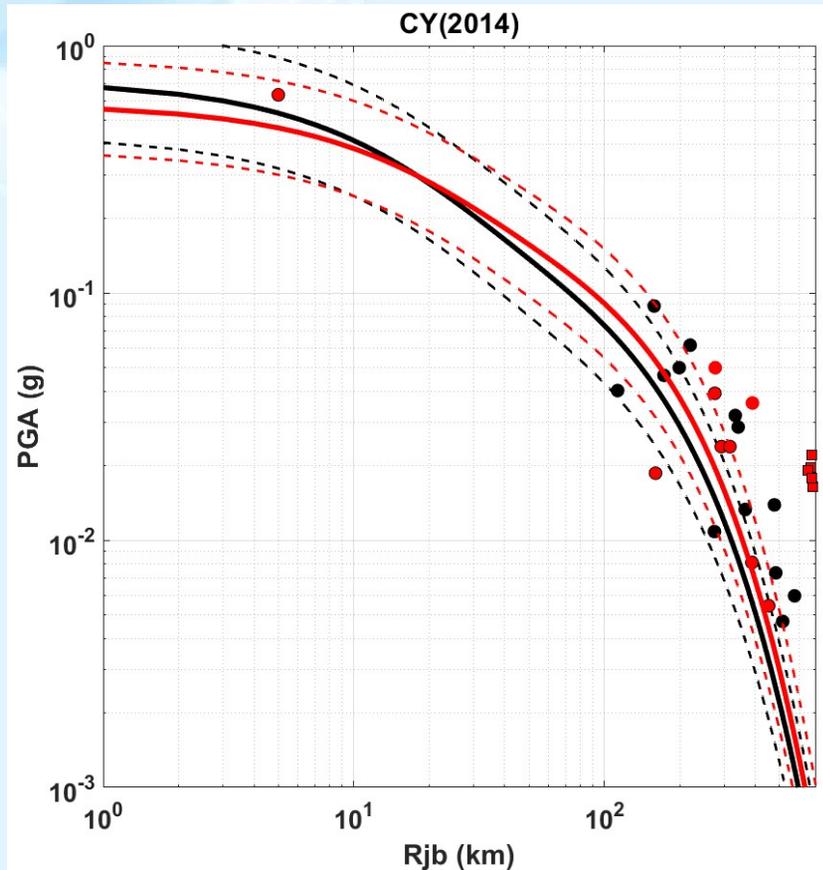


Bangkok Basin Seismic Design Spectrum



A distinctive shape with high spectral acceleration centered at about 1 s, and a very small acceleration reduction between short periods and periods around 2.0 seconds. Bangkok is in zone 5.

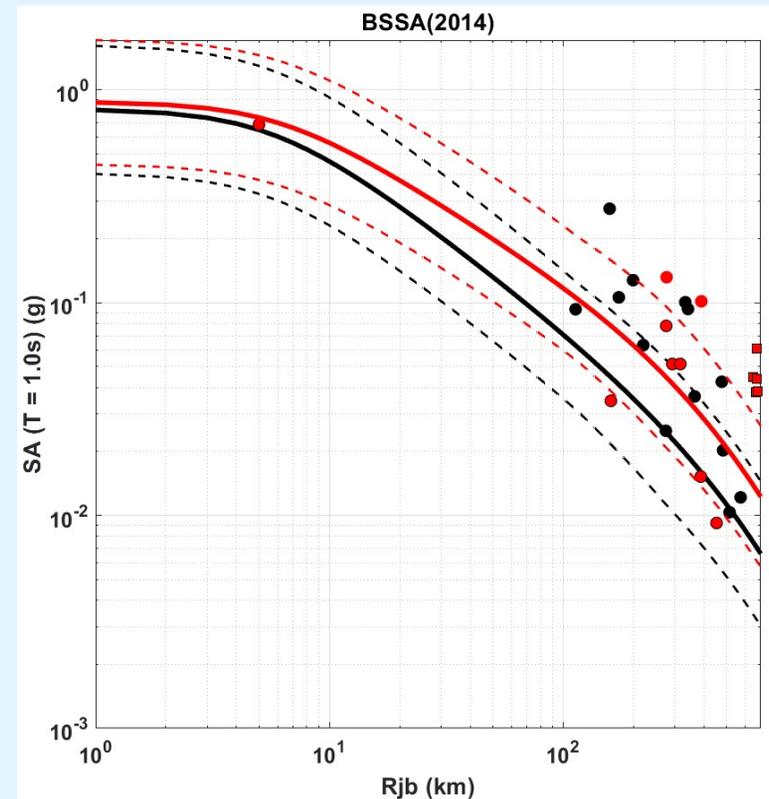
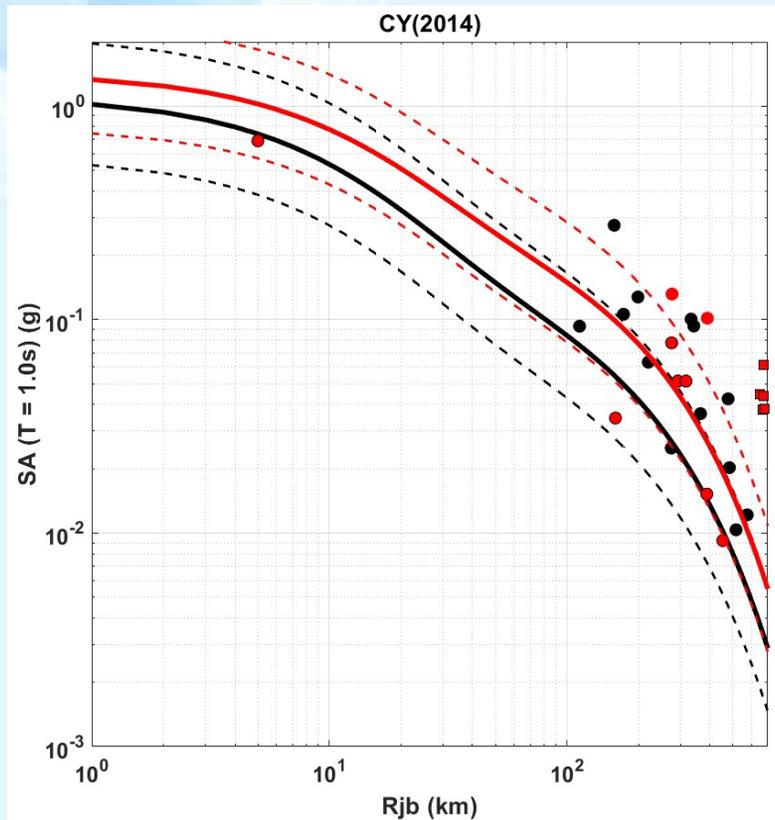
Comparison of PGA from 2025 Mw 7.7 Mandalay with BSSA14 & CY14



- Bangkok
- Soft soil
- Stiff soil

- BSSA14 & CY14 underestimate the recorded PGA
- PGA for Bangkok basin stations is about 4 times greater than those outside basin
- The underestimation of GMMs due to rupture directivity?

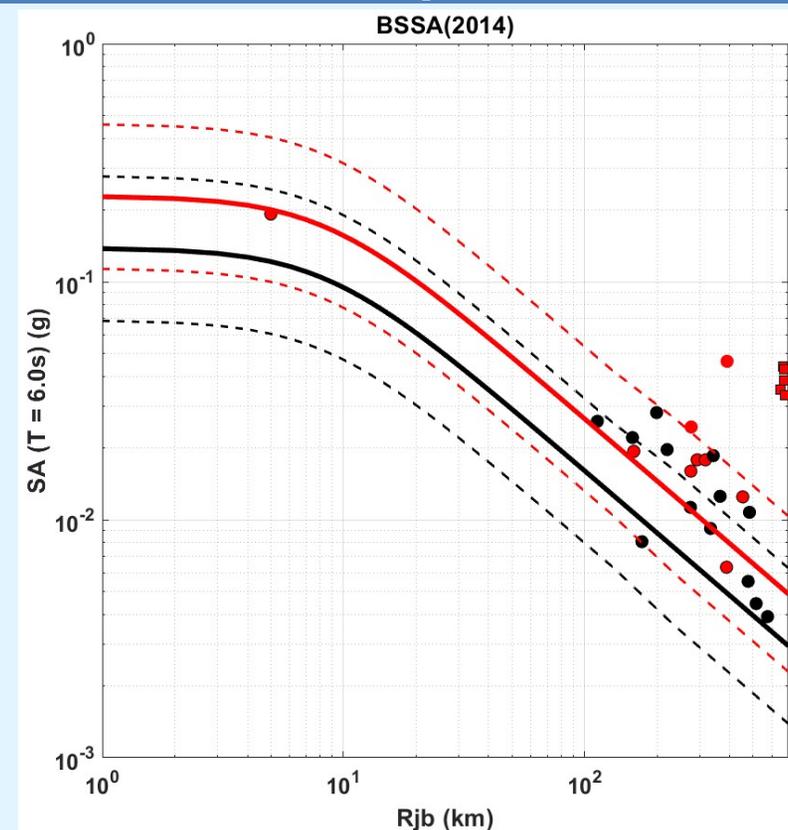
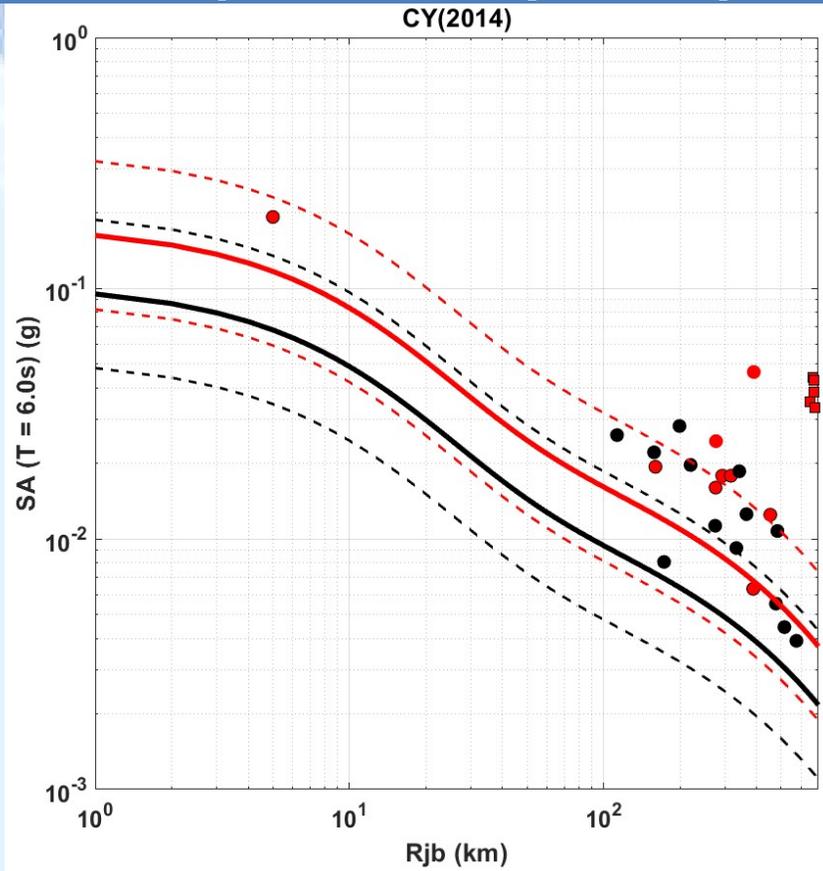
Comparison of SA ($T = 1.0s$) from 2025 Mw 7.7 Mandalay with BSSA14 & CY14



- Bangkok
- Soft soil
- Stiff soil

- BSSA14 & CY14 still underestimated the recorded SA ($T = 1.0s$)
- Larger variability comparing to PGA might be due to different basin amplification?
- SA ($T = 1.0s$) for Bangkok stations are 4 times greater than stations outside basin

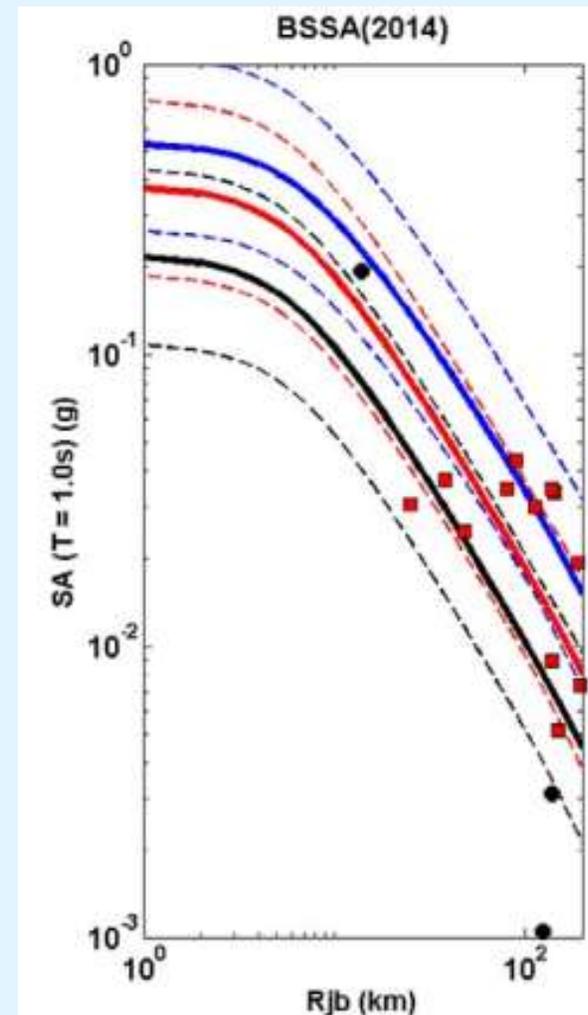
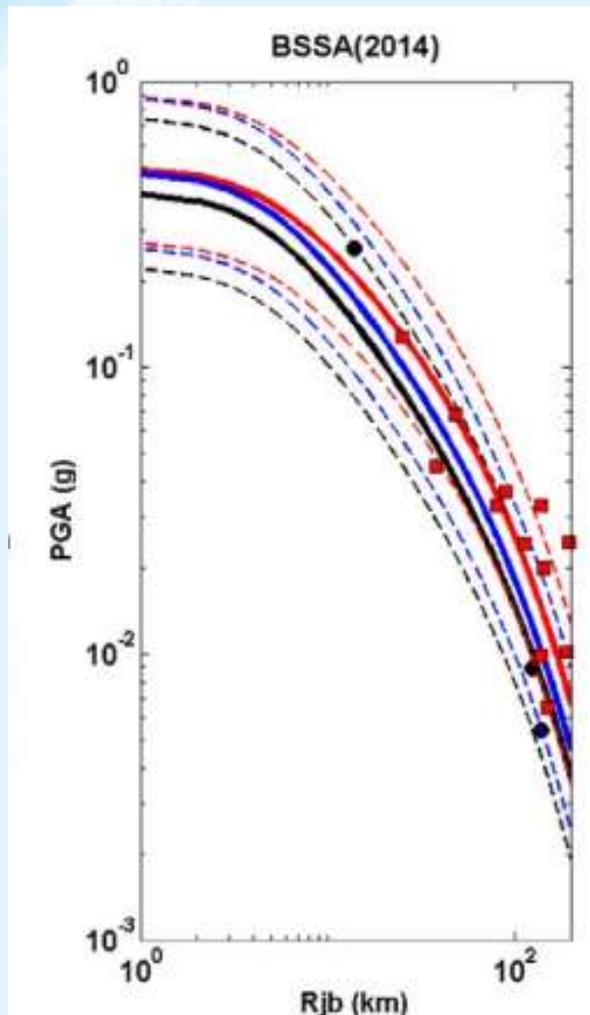
Comparison of SA ($T = 6.0s$) from 2025 Mw 7.7 Mandalay with BSSA14 & CY14



- Bangkok
- Soft soil
- Stiff soil

- BSSA14 & CY 14 still underestimate the recorded ground motion
- Larger variability for SA ($T = 6.0s$) comparing to PGA
- SA ($T = 6.0s$) in Bangkok basin stations is about 10 times greater than stations outside basin

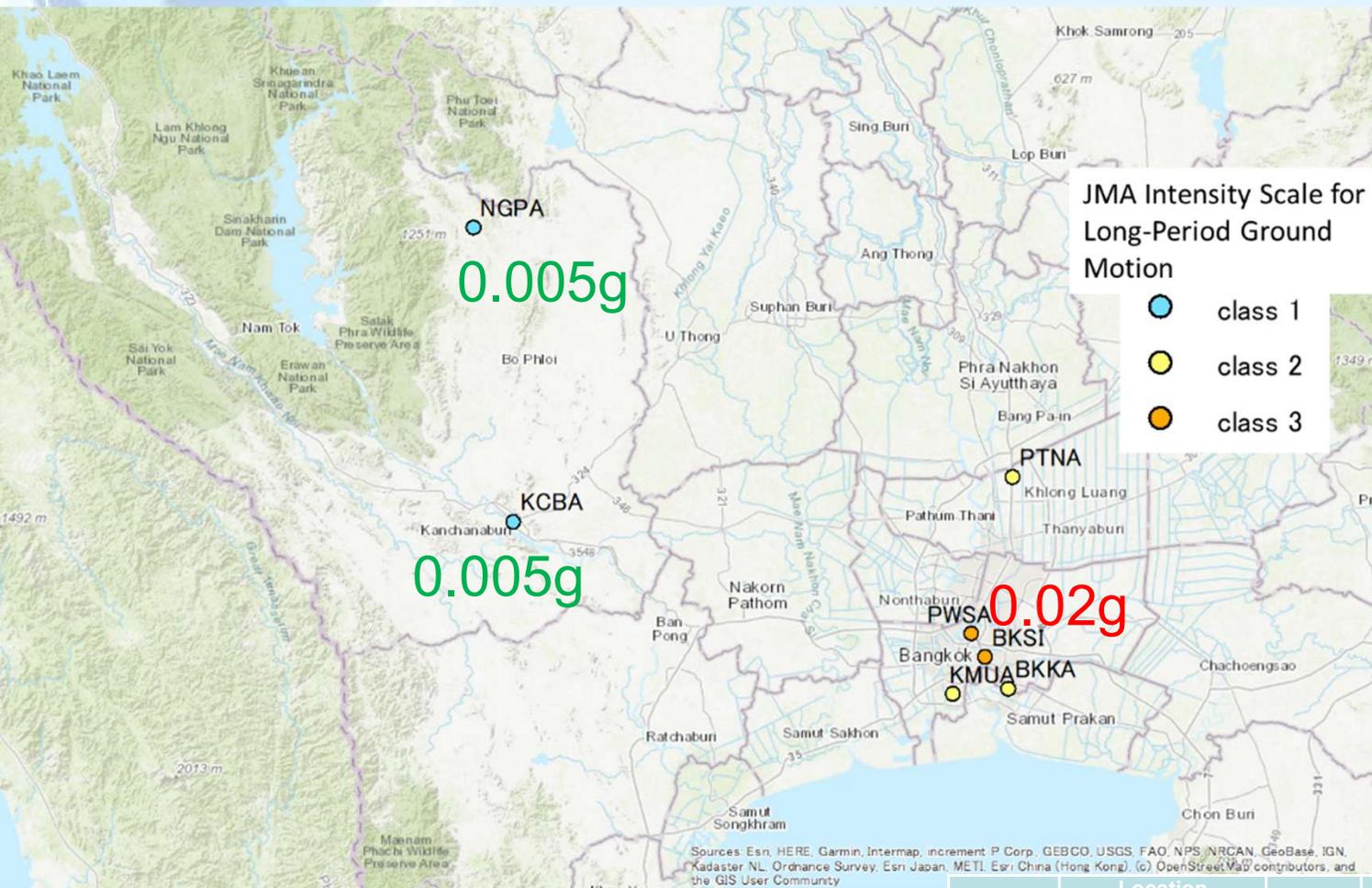
Comparison of PGA from 2014 Mw 6.3 Northern Thailand with BSSA14



- BSSA14 give comparable to recorded PGA & SA (T = 1.0s)
- Still large variability for recorded SA (T = 1.0s) than PGA
- SA (T = 1.0s) in Bangkok stations show clear amplification

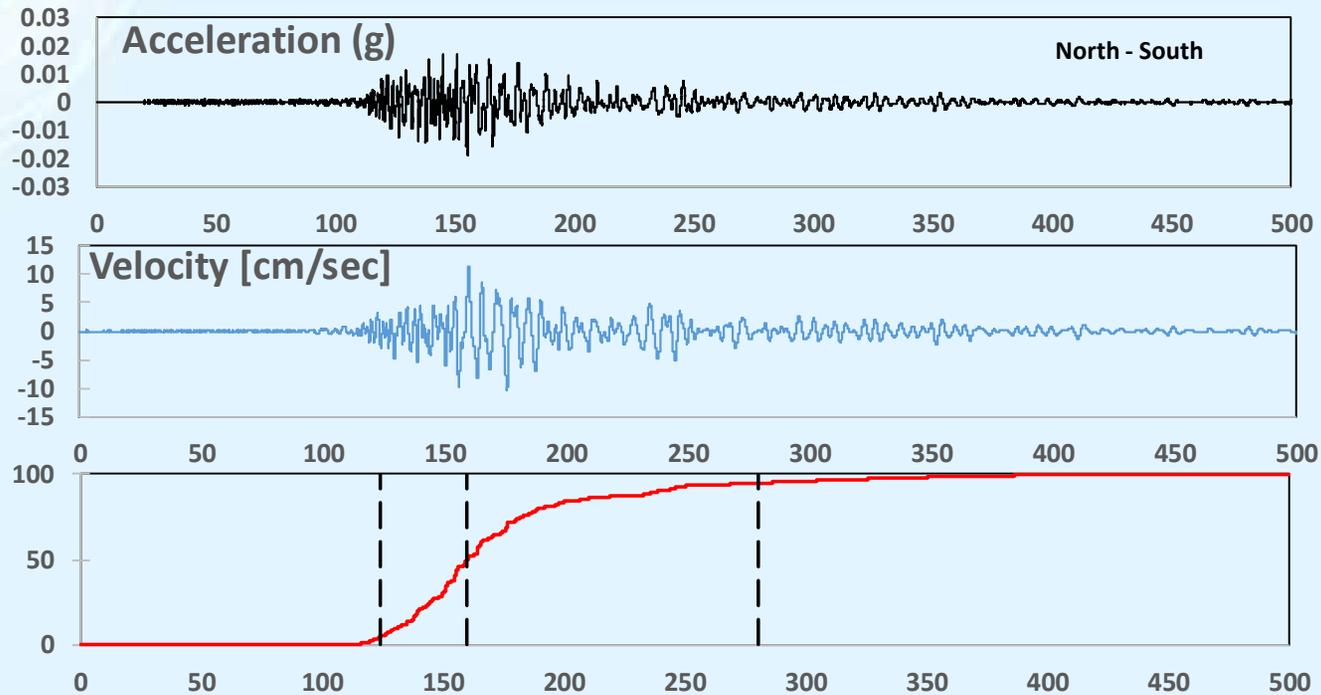


Comparison of Recorded PGA inside and outside Bangkok Basin



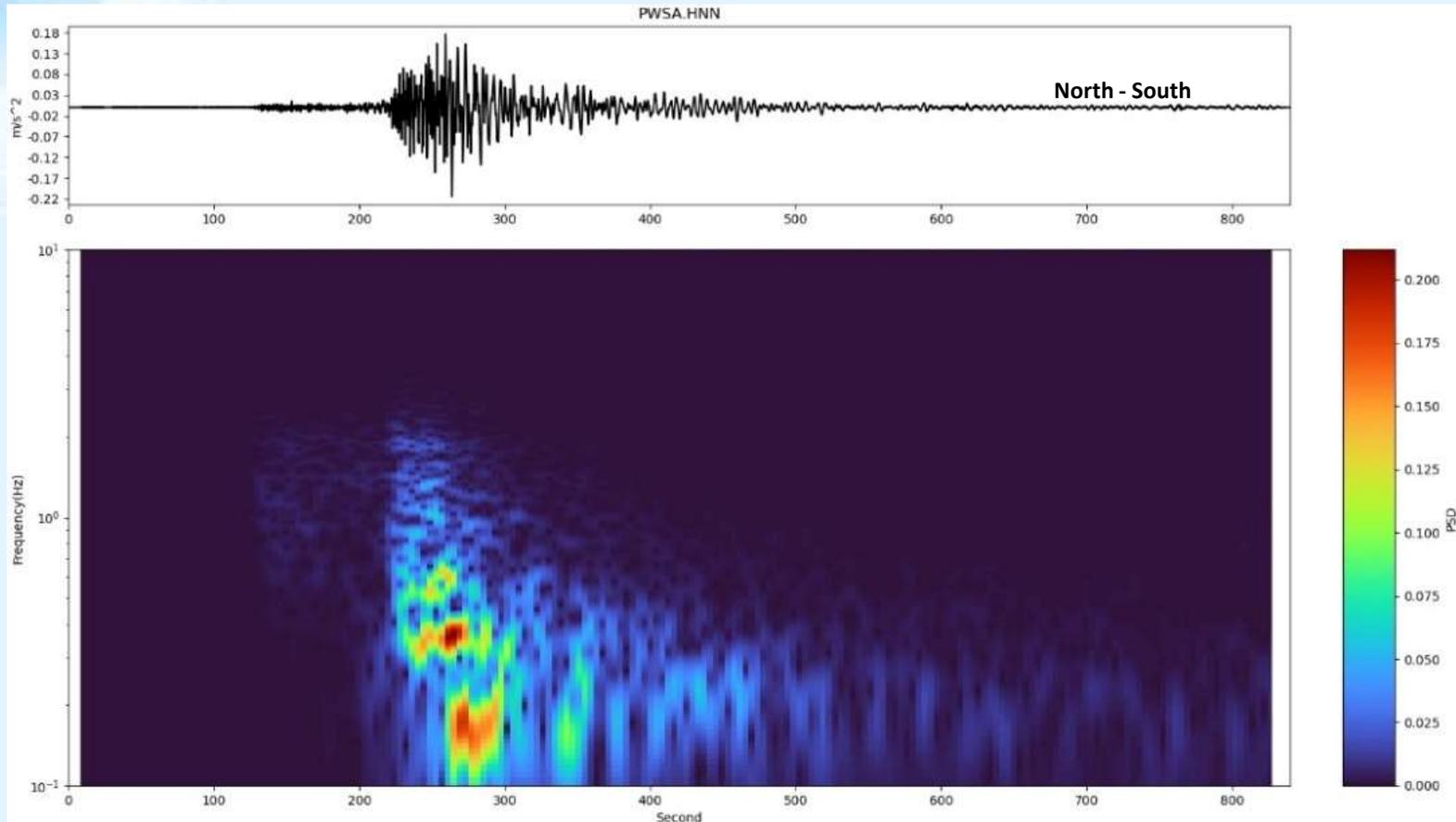
Station	Location		Rjb (km)	IMs					
	Lat (N)	Long (E)		PGA (g)		PGV (cm/s)		D5-95 (s)	
				NS	EW	NS	EW	NS	EW
PWSA	13.78	100.53	667	0.019	0.023	11	14	156	133
BKS1	13.73	100.56	673	0.019	0.016	13	10	146	130
PTNA	14.12	100.62	647	0.016	0.019	6	6	113	113
KMUA	13.65	100.49	675	0.022	0.022	13	8	126	149
BKKA	13.66	100.61	678	0.016	0.021	9	8	154	159
KCBA	14.02	99.53	574	0.005	0.006	1.8	2.5	81	98
NGPA	14.66	99.45	515	0.004	0.005	1.4	2.5	112	82

Strong Motion 2025 Mw 7.7 Mandalay at PWSA station

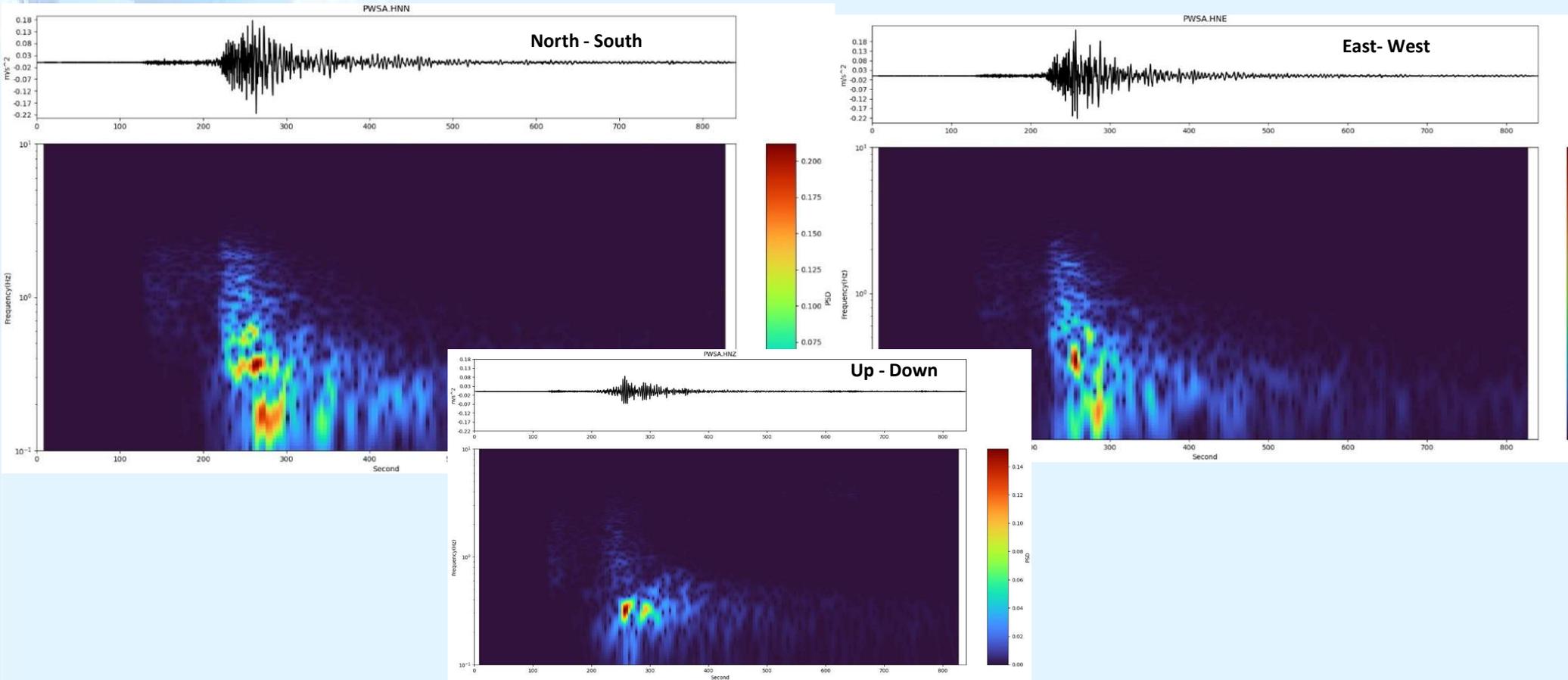


- Body & Surface waves could be clearly separated
- PGA & PGV observed once surface wave is developed within the 90% significant duration

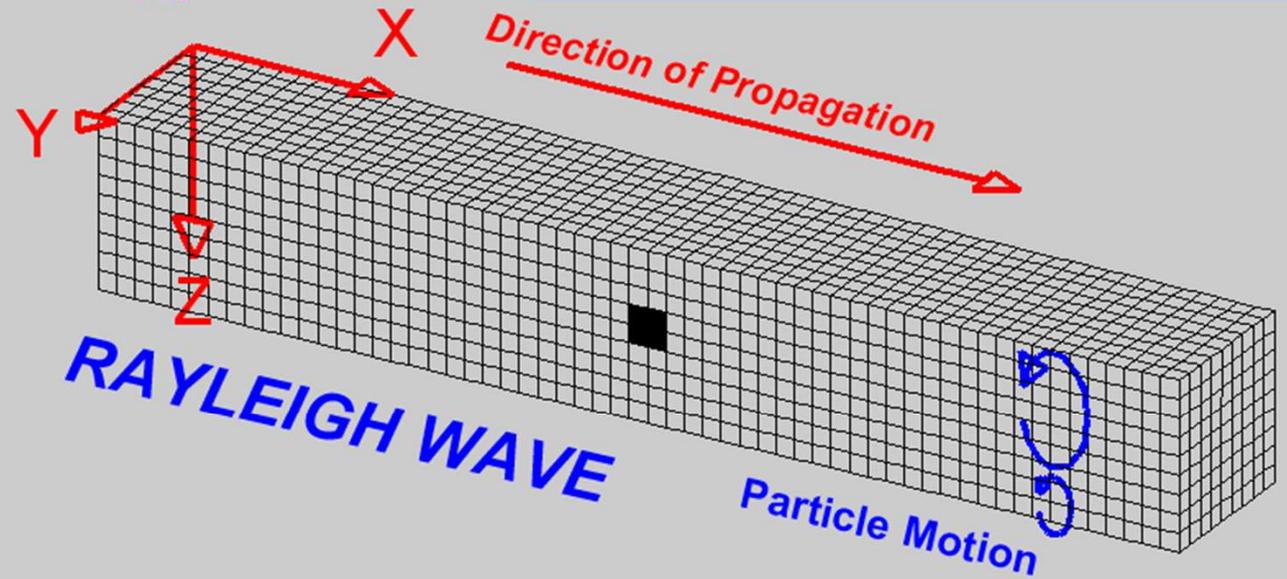
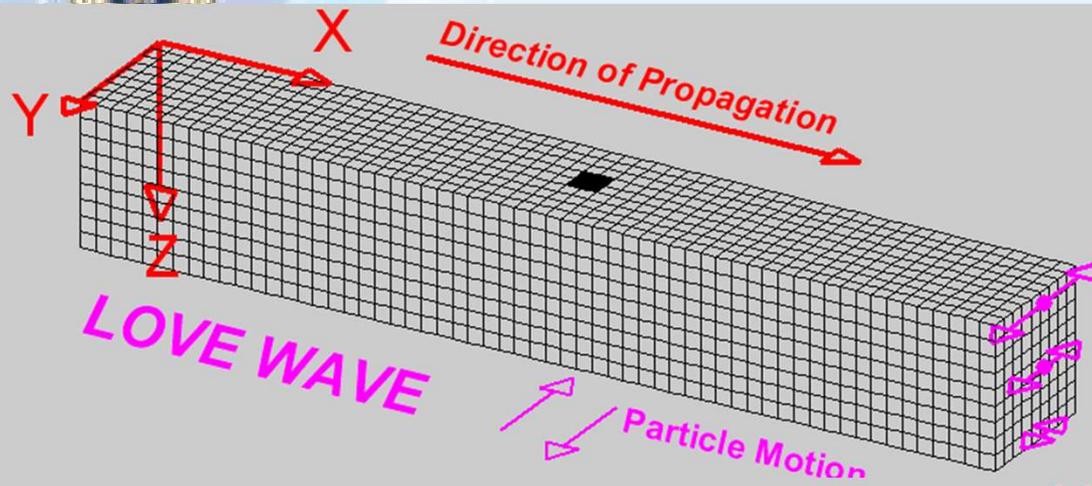
Strong Motion 2025 Mw 7.7 Mandalay at PWSA station



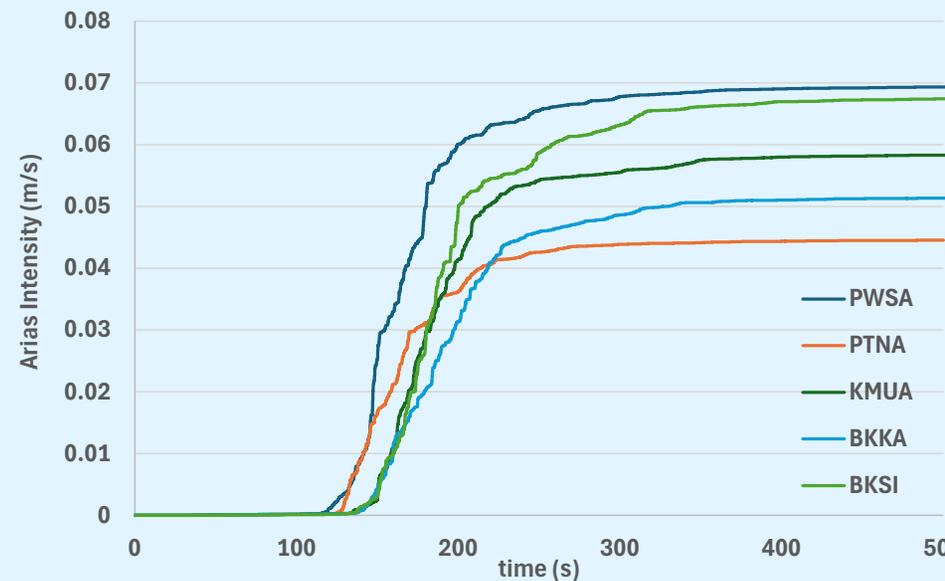
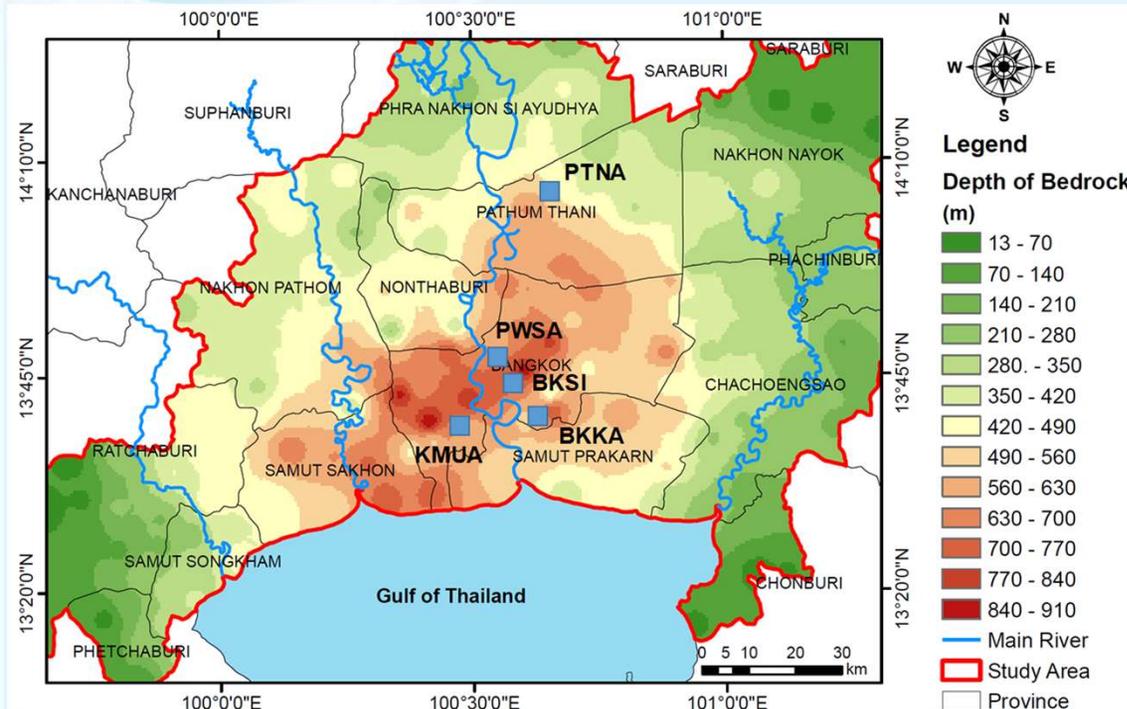
- Long period energy between 0.2 – 0.4 Hz (2.5 – 5s) observed with the arrival of S wave
- Long period energy between 0.1 – 0.2 Hz (10 – 5s) observed with the arrival of Surface wave



- S Wave dominate the first 50% of Arias Intensity period between 2.5 to 5s
- Surface Wave dominate the second 50 % of Arias Intensity period between 5 to 10s
- Only observed long period energy between 5s to 10s in horizontal direction indicating Love wave generating within the basin



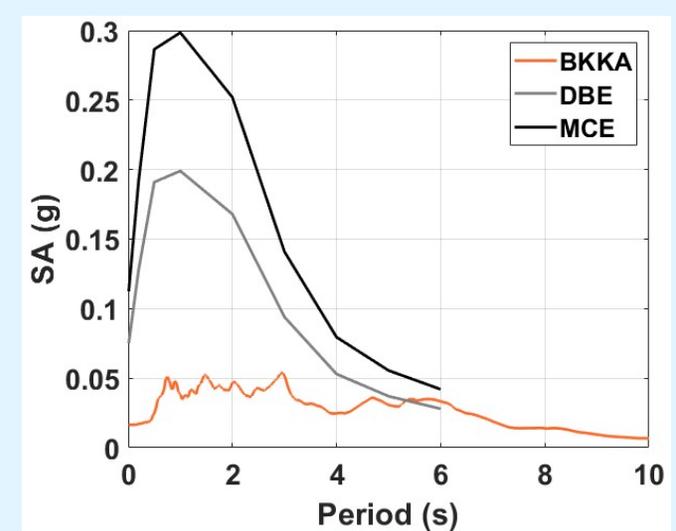
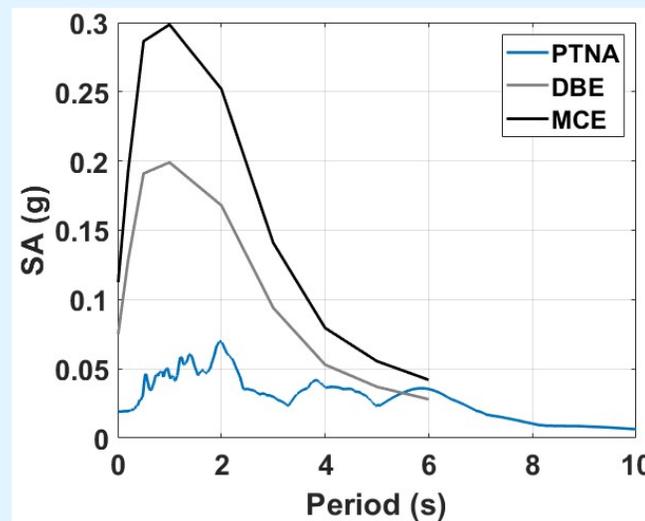
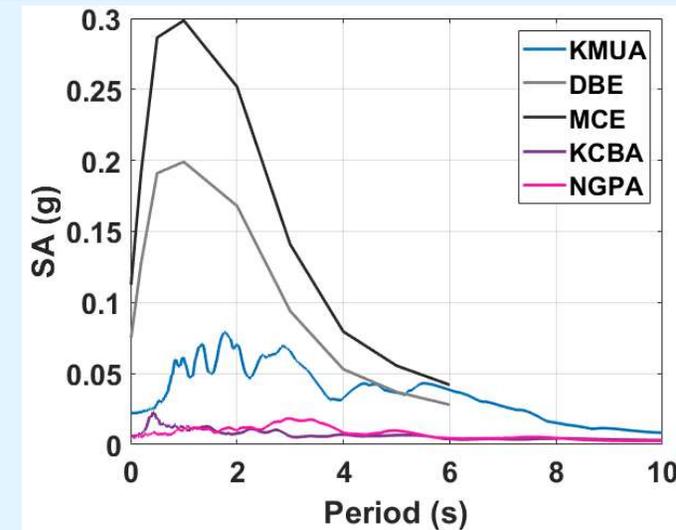
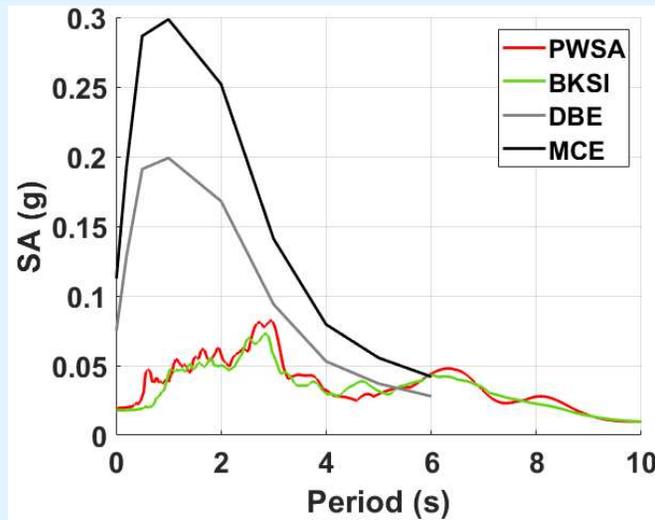
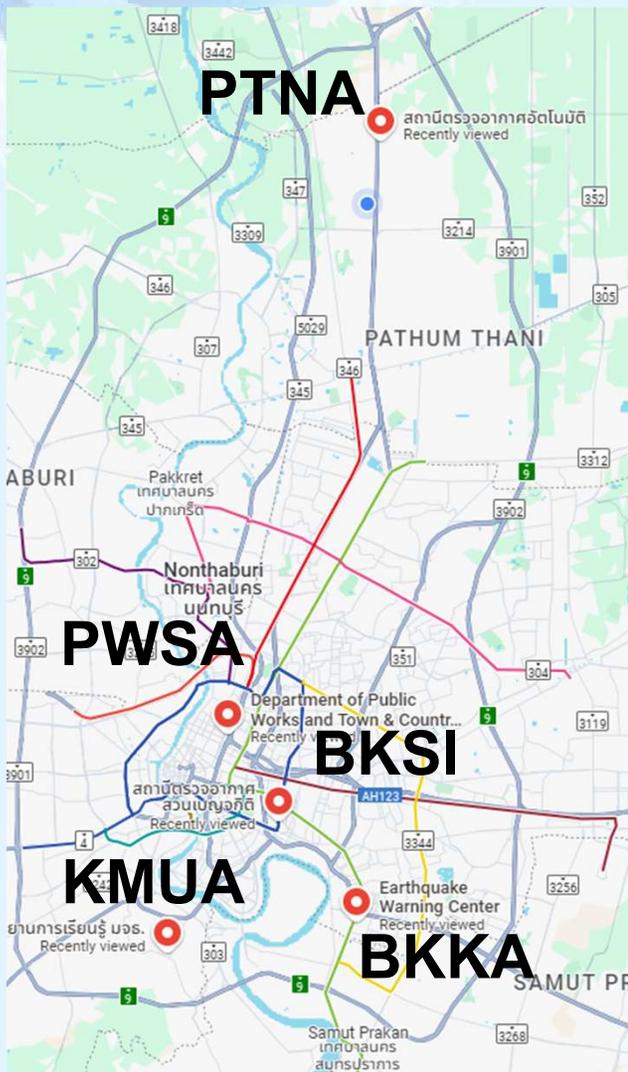
Correlation of Bangkok stations and available geological structure



- Cumulative Velocity are highest for stations location at the deepest part of basin.
- PWSA & BKSI located where the deepest part to bedrock around 900 m.
- PTNA station located at the edge of basin show the lowest Cumulative Velocity.



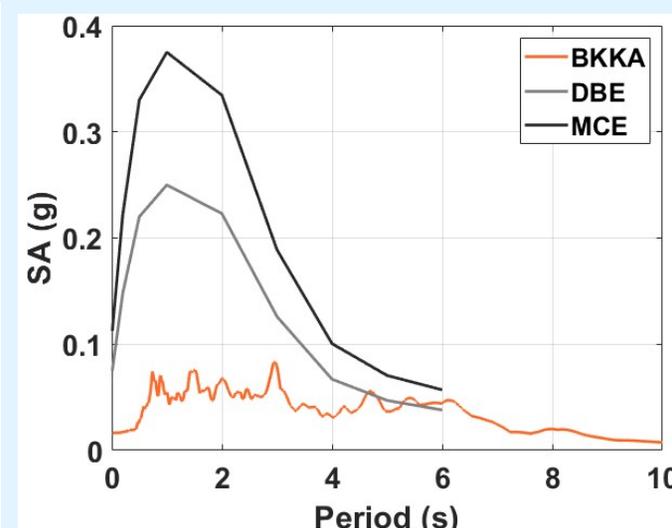
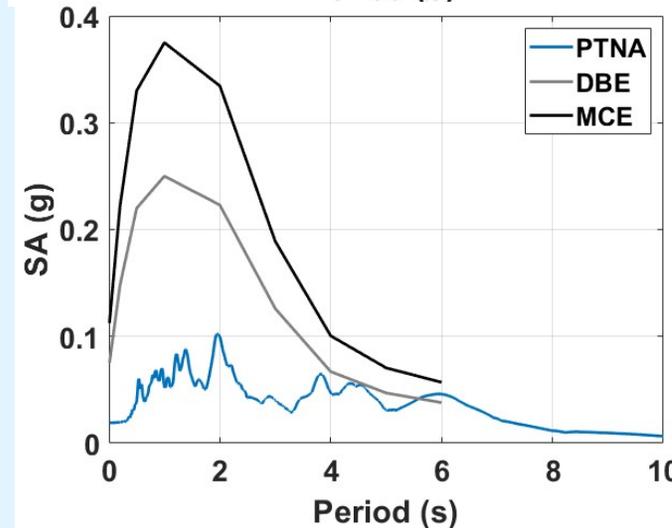
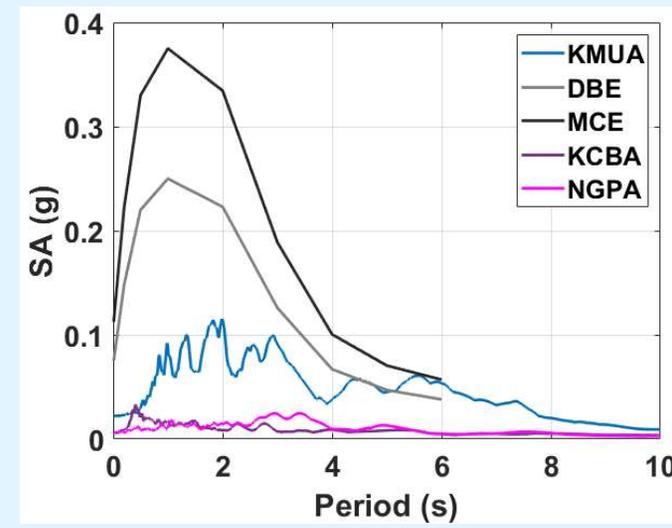
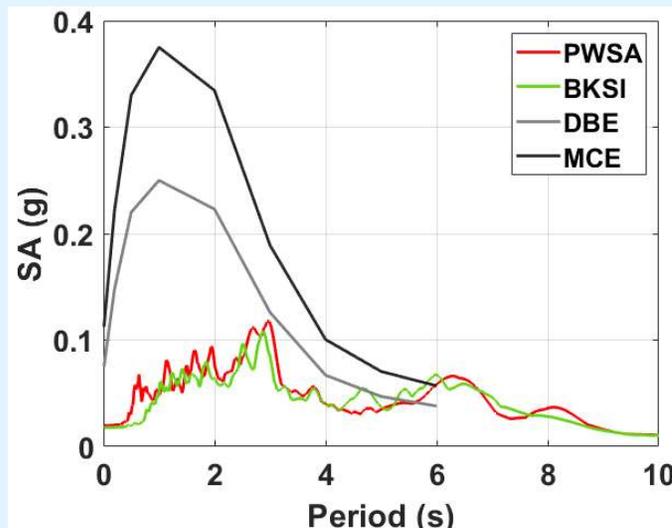
Comparison between observed & design 5% damping spectrum



- All recorded station has PGA about 0.02g
- Different stations observed different amplification (PWSA at 3s while PTNA at 2s)



Comparison between observed & design 2.5% damping spectrum



- All recorded stations have PGA about 0.02g
- Different stations observed different amplification (PWSA at 3s while PTNA at 2s)

Conclusion

- Seismic Design Code in Bangkok has been incorporated Large Earthquake at Long Distance.
- Bangkok station amplify both amplitude and duration comparison to station located outside the basin.
- Most long period energy content located when surface wave arrived.
- High spectral acceleration could be observed at low damping (2.5 and 1 % damping values) might be a concern for tall buildings.
- Stations located in the deepest part of Bangkok basin show long period amplification which has been previously observed.
- ***Soil Nonlinearity, Polarization, directionality , Damping Scaling Factor, Surface Wave?!***