



Boğaziçi University  
Kandilli Observatory and Earthquake Research Institute  
Department of Earthquake Engineering

**Kahramanmaraş - Gaziantep Türkiye**  
**M7.7 Earthquake, 6 February 2023**  
**(04:17 GMT+03:00)**

**Strong Ground Motion and Building Damage Estimations**  
**Preliminary Report (v4)**

*Ufuk Hancılar, Karin Şeşetyan, Eser Çaktı*

*Nesrin Yenihayat, Hakan Süleyman, Nurullah Açıkgöz, Şahin Dede, Şükran Acar*

09.02.2023 (v4)  
08.02.2023 (v3)  
07.02.2023 (v2)  
06.02.2023 (v1)

## What is new?

### V4 (09.02.2023):

**More info on the strong ground motion recordings!**

**Acc-vel-disp time histories, FAS and horizontal resp. spectra plots updated and vertical resp. spectra plots added!**

**Maps showing the PGA values of the stations along with the active fault lines provided!**

**Aftershock activity map presented!**

**PGA and PGV residual analyses with four GMPEs for the M7.7, M7.6 and M6.6 (6 Feb 2023) earthquakes provided!**

## Previous Versions

### V3 (08.02.2023):

**More info on the strong ground motion recordings!**

**Strong ground motion records, downloaded from AFAD website and processed! Acc-vel-disp time histories, FAS and elastic acc. resp. spectra plots!**

**Kahramanmaraş city scale building damage estimation with different methods: Modified Acceleration-Displacement Response Spectrum Method, Capacity Spectrum Method and Displacement Coefficient Method.**

**It is estimated that approximately 40% of the Kahramanmaraş's building inventory in (moderate+extensive+complete) damage state!**

### V2 (07.02.2023):

**Ground motion distribution maps with different GMPEs and intensity prediction equations!**

**Regional scale damage estimation maps with different ground motion inputs!**

**Kahramanmaraş city scale damage estimation maps with different ground motion inputs!**

**Acceleration, velocity and displacement time history plots, Fourier amplitude spectra plots of the recorded data!**

### V1 (06.02.2023):

**Rapid estimation of spatial distributions of strong ground motion parameters!**

**Intensity based, regional scale, rapid building damage estimation!**

**Spectral acceleration-displacement based rapid building damage estimation for Kahramanmaraş city!**

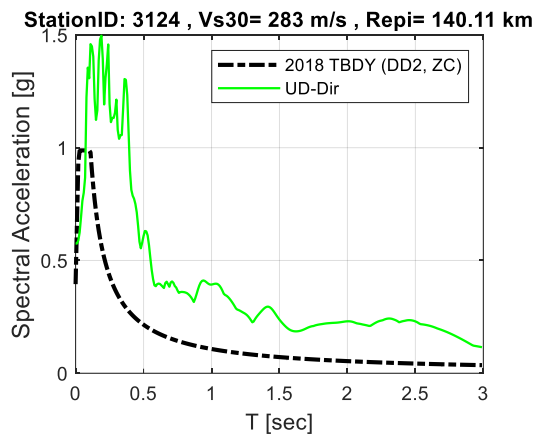
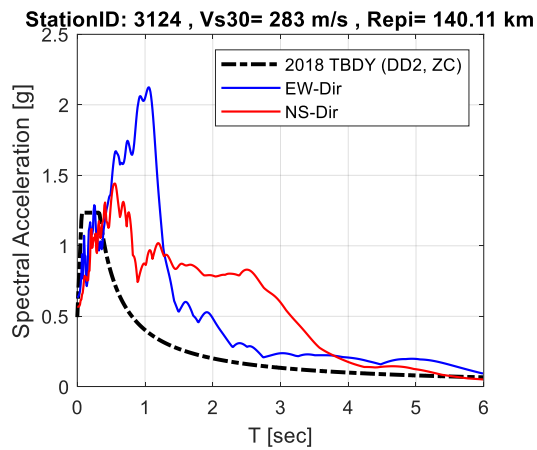
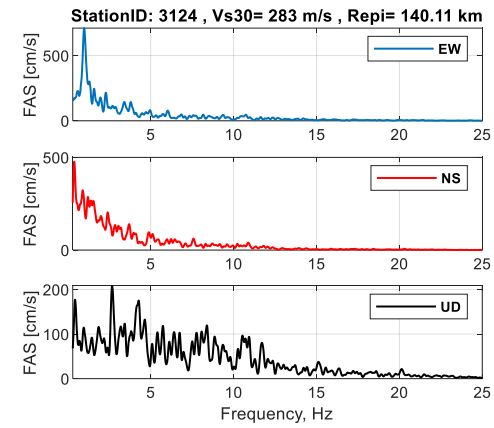
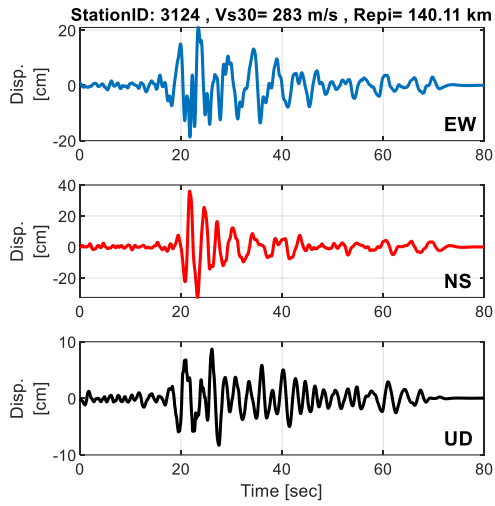
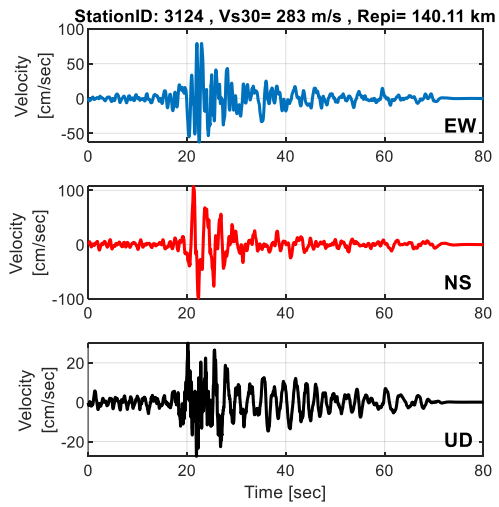
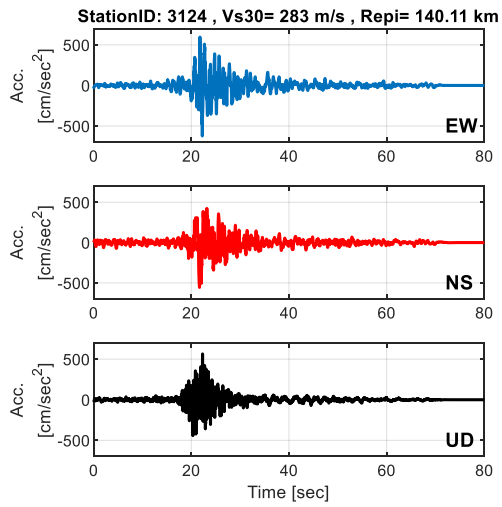
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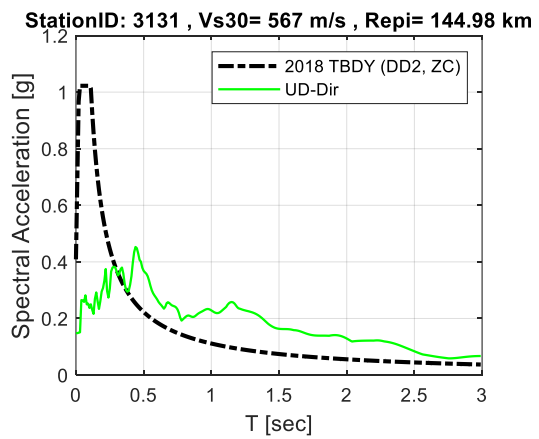
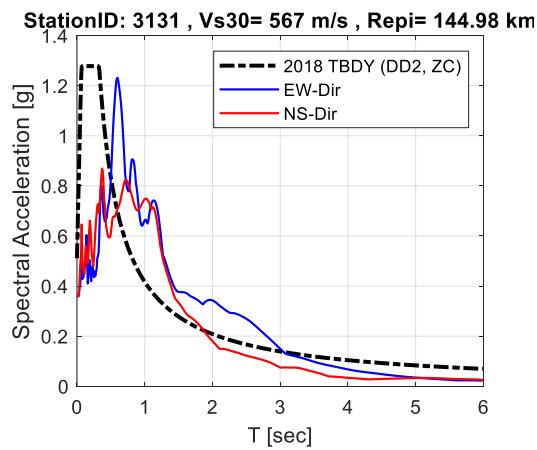
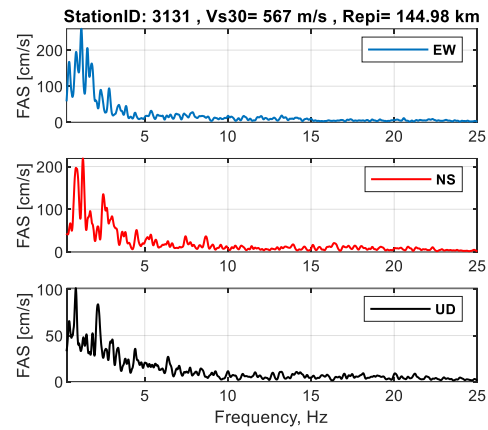
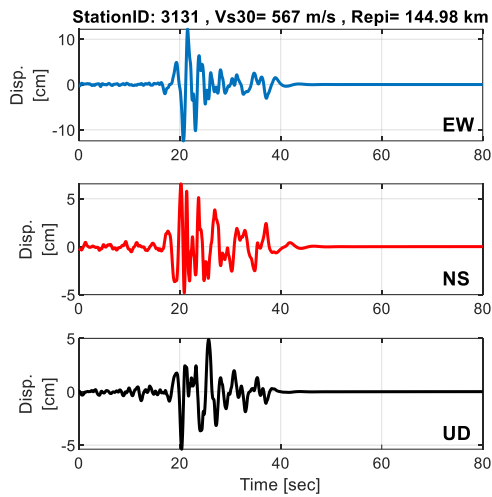
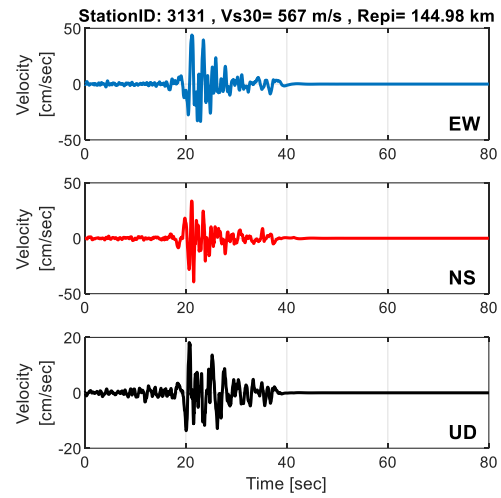
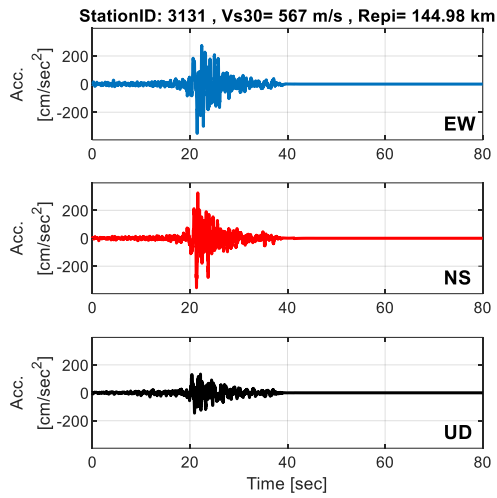
**The information provided in this report is presented for scientific research purposes.**

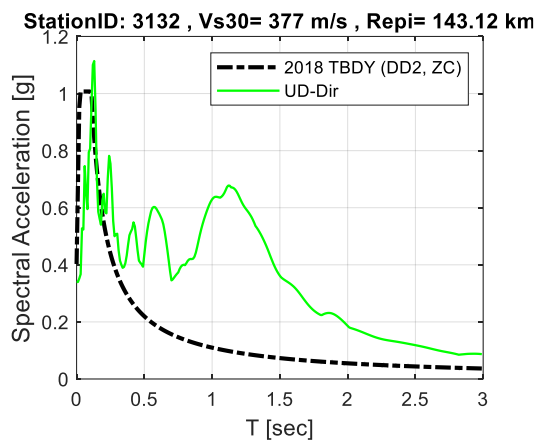
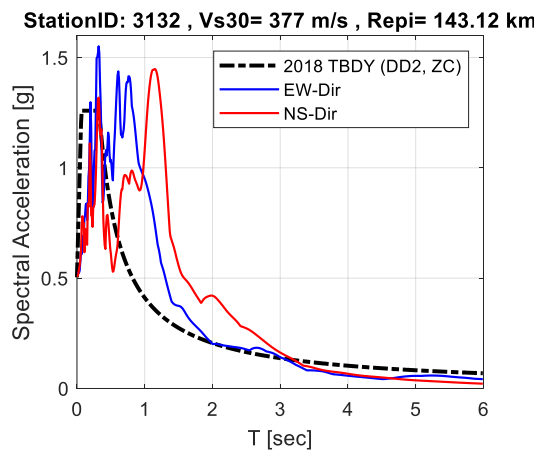
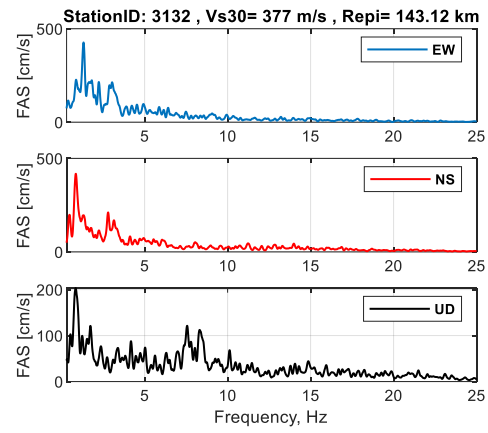
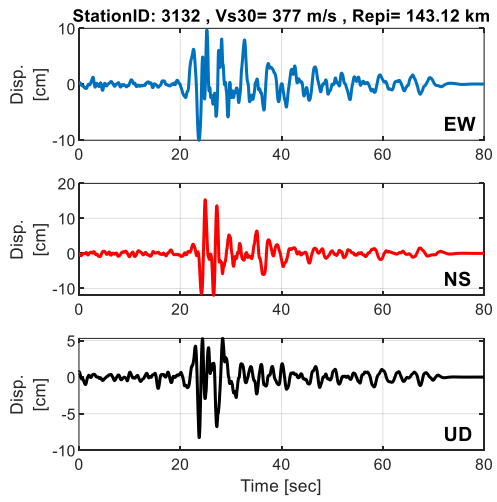
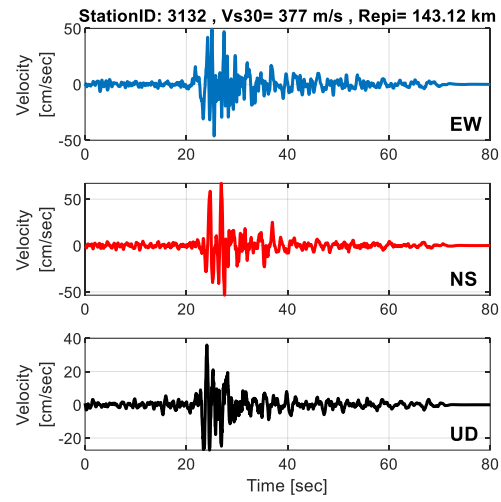
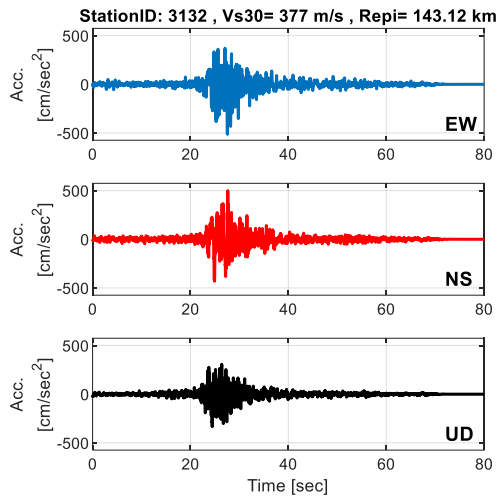
**Ground motion and building damage estimation analyses conducted with ELER (Earthquake Loss Estimation Routine) software.**

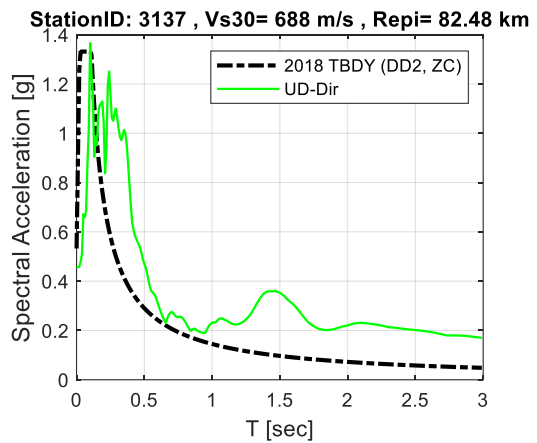
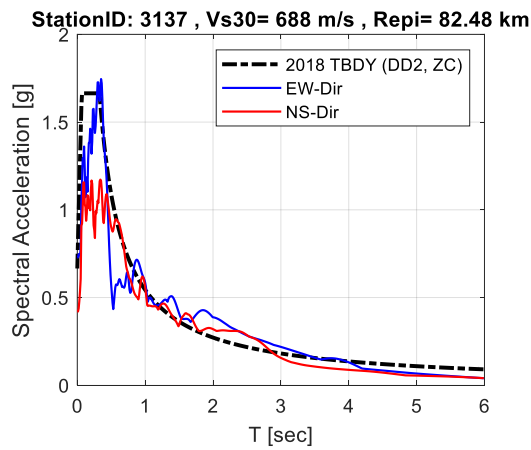
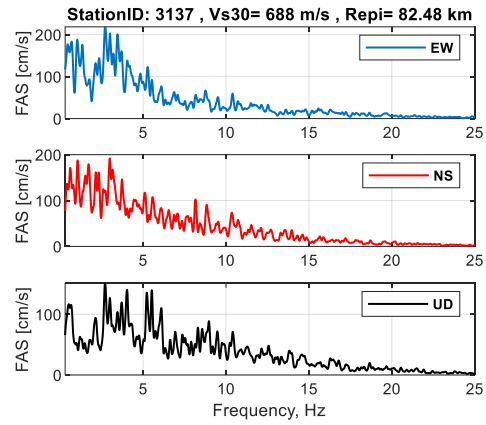
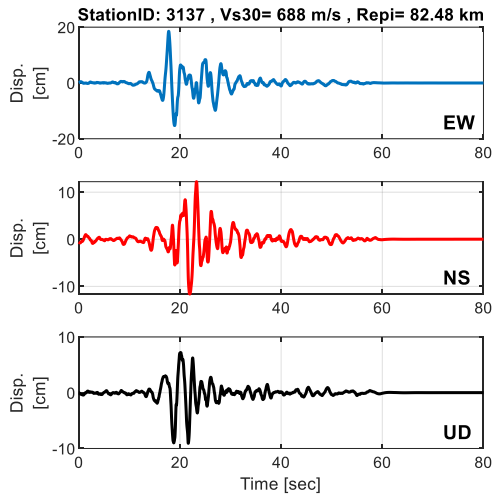
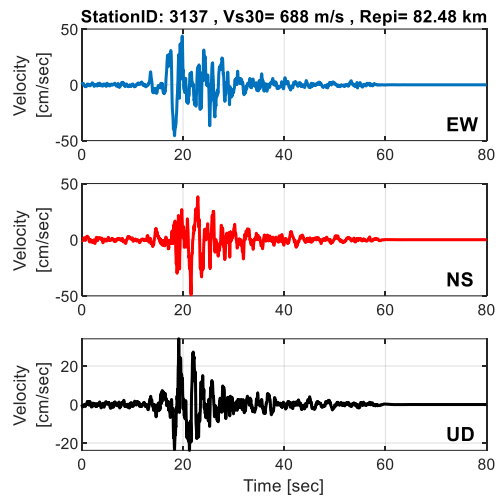
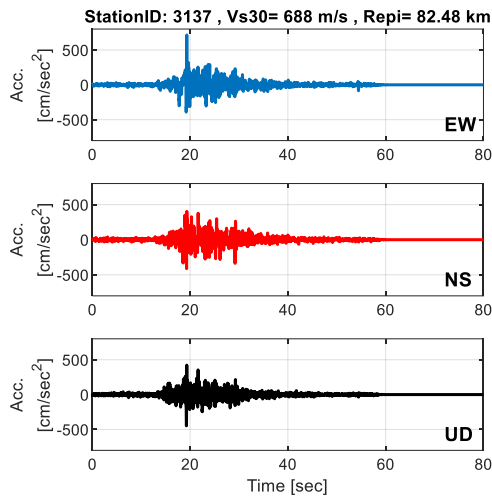
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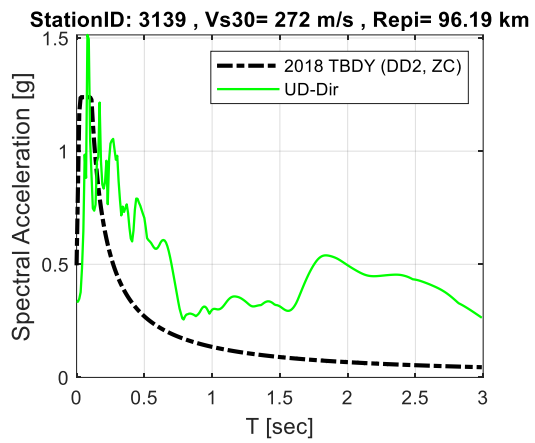
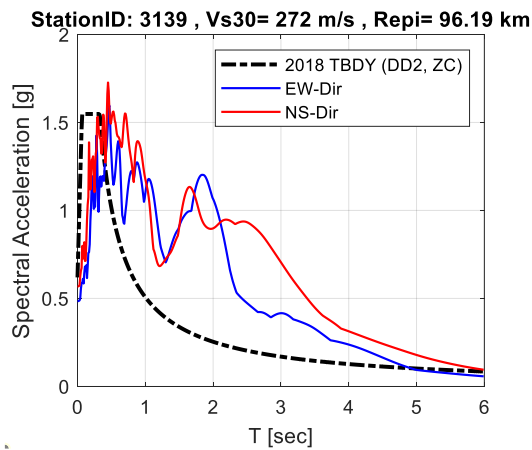
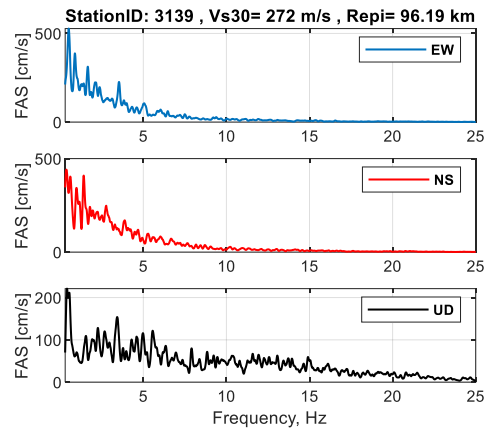
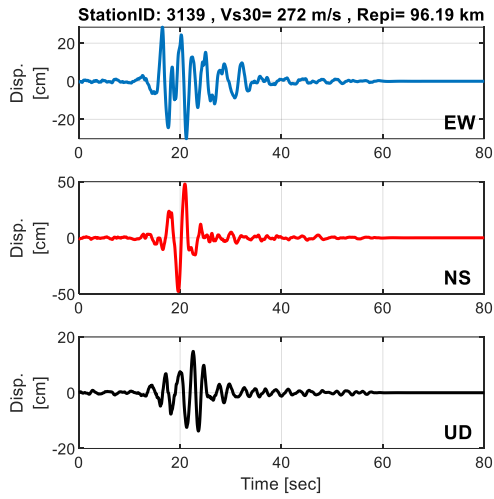
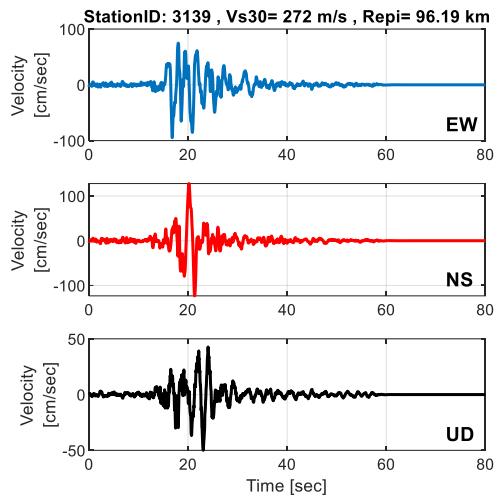
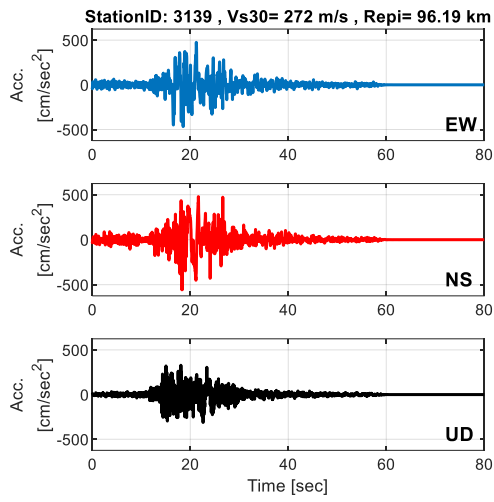




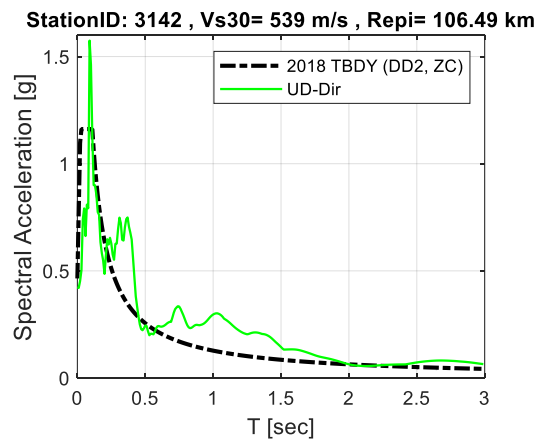
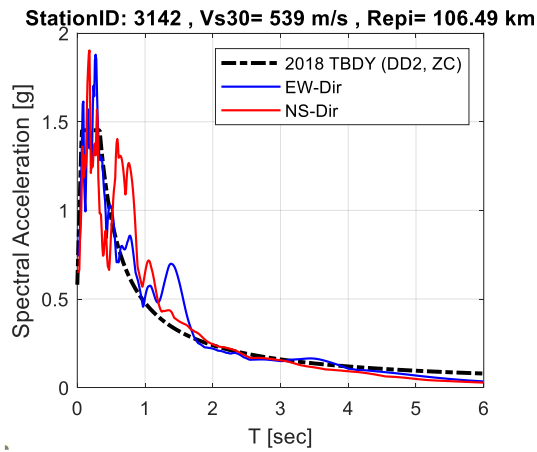
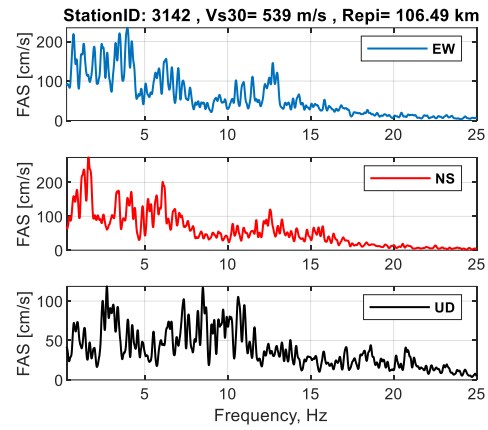
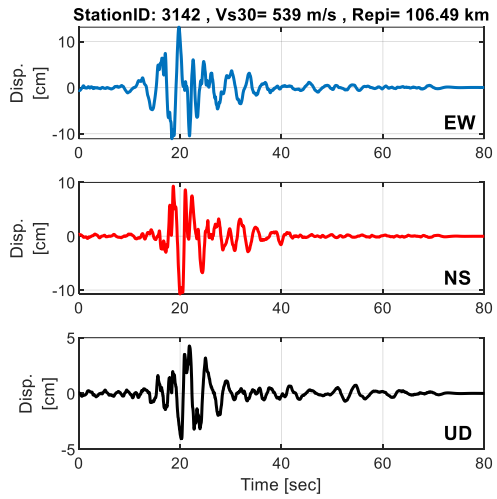
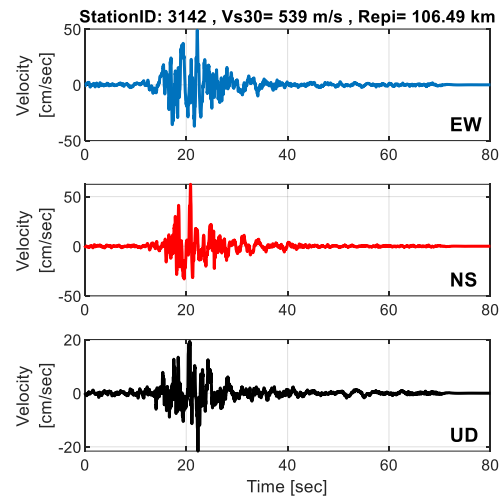
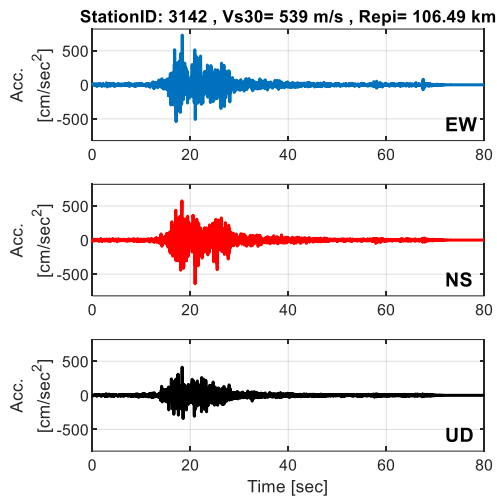


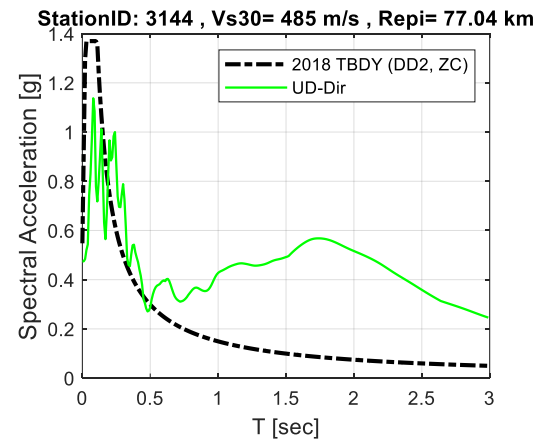
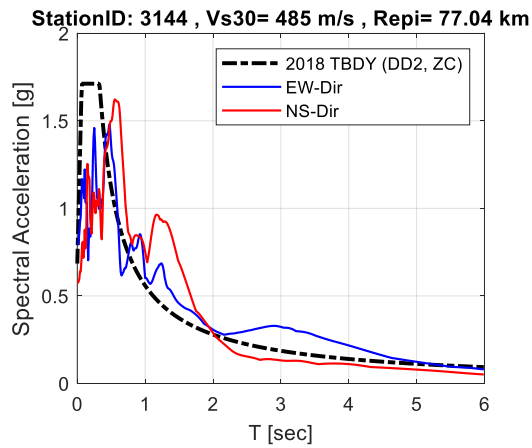
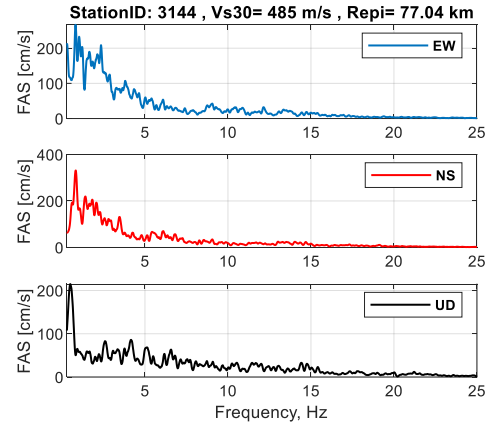
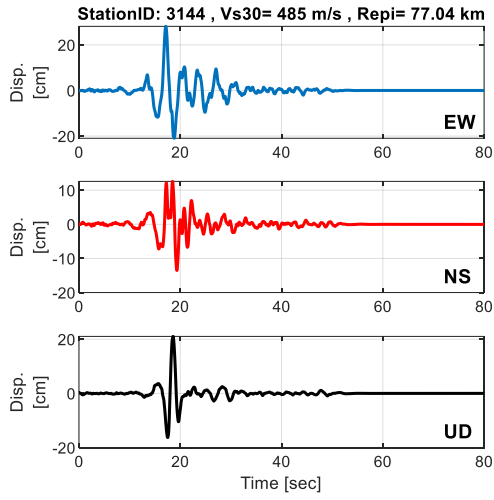
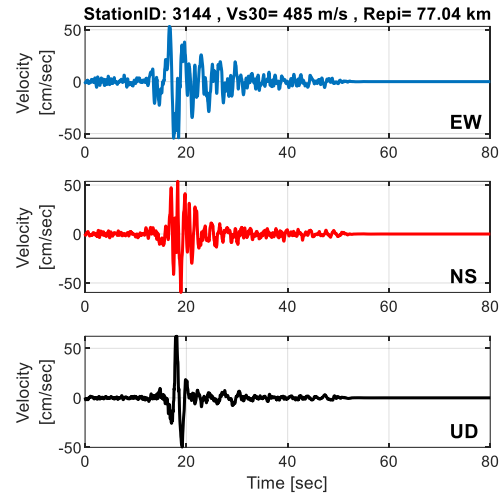
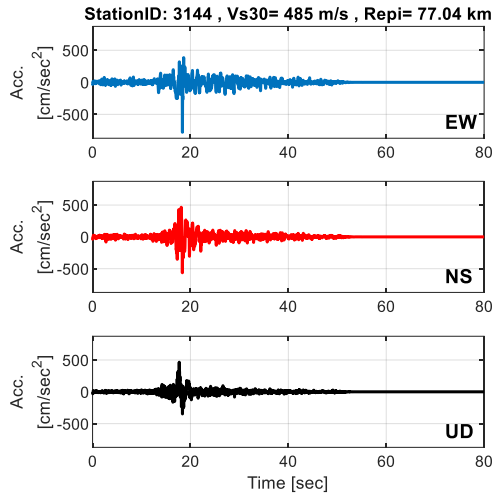


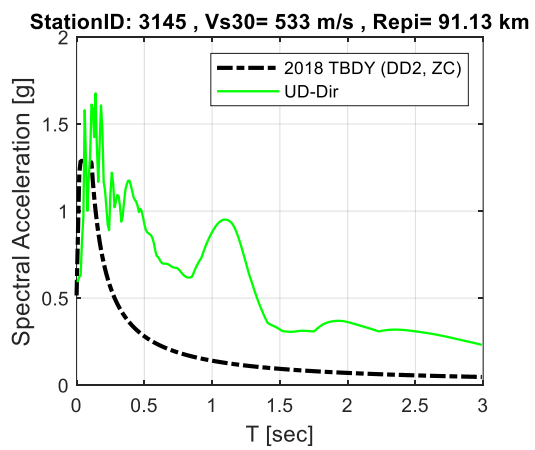
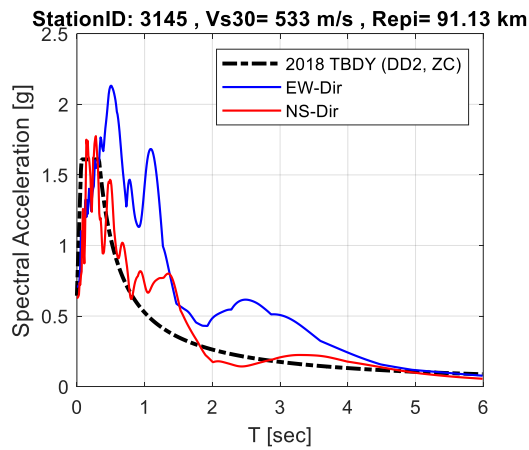
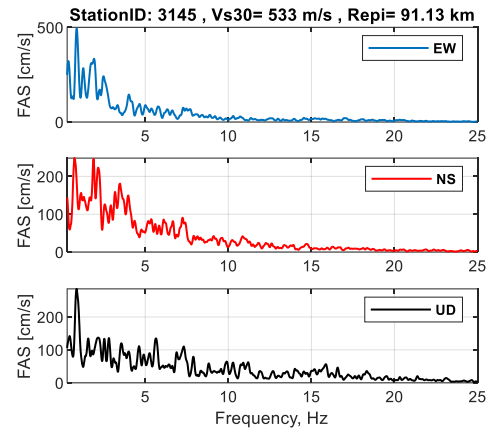
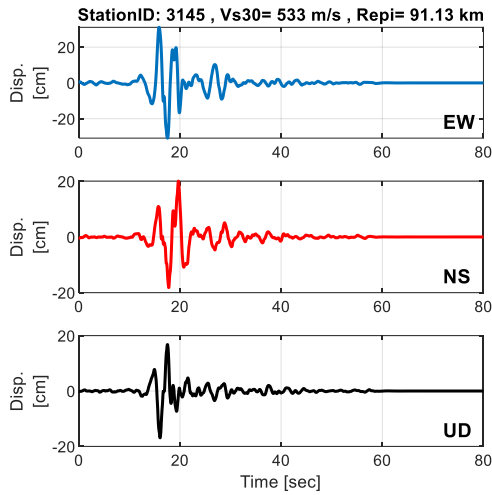
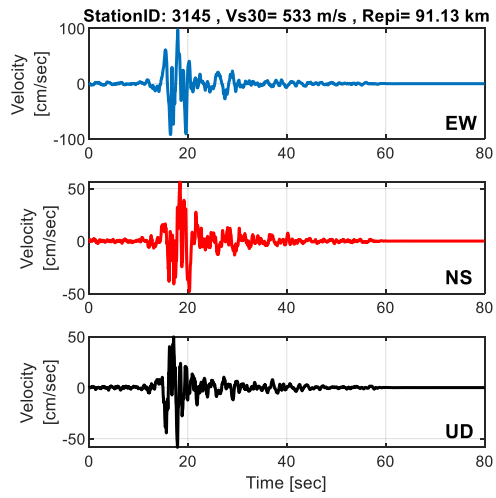
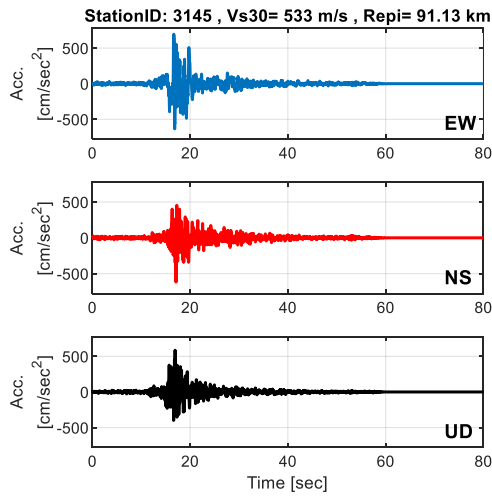






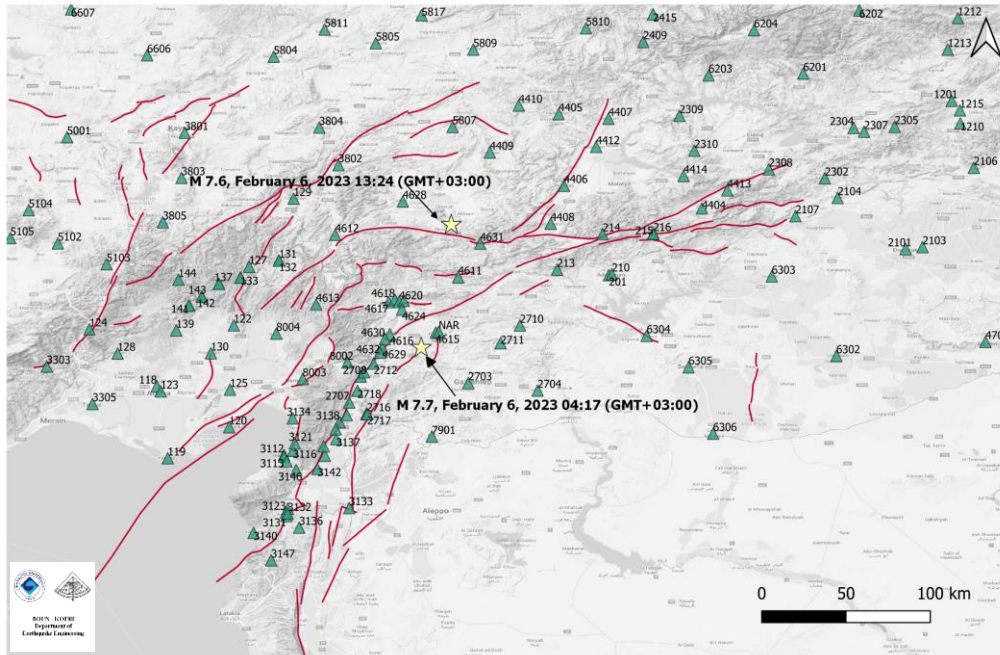




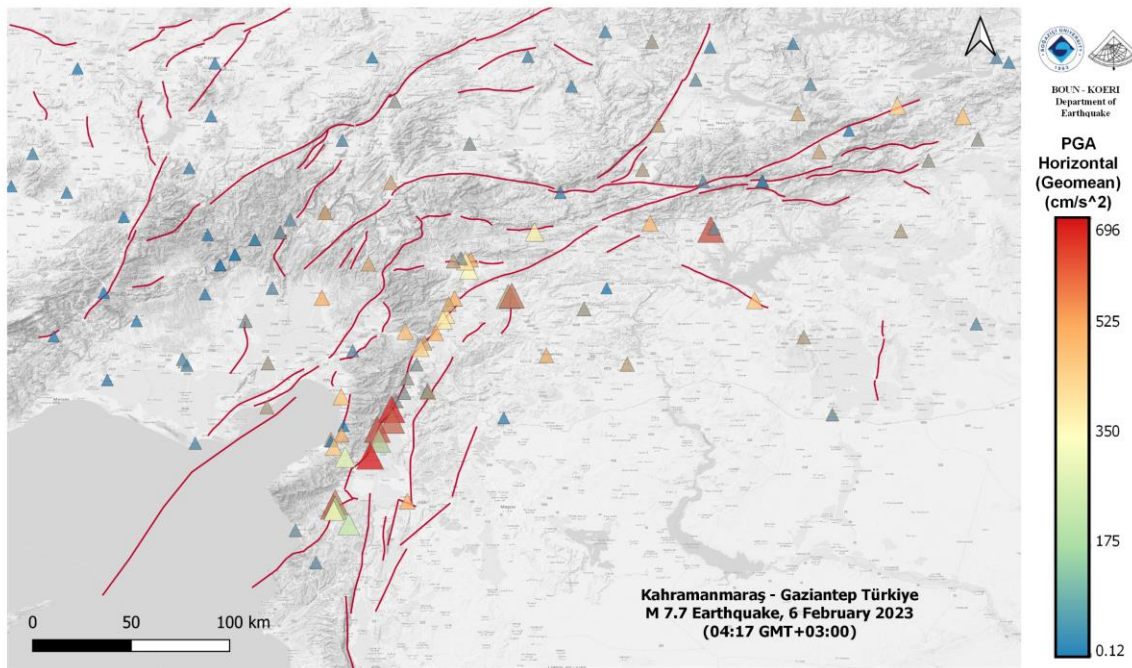


ID	Lat.	Lon.	Vs30 (m/s)	R <sub>epi</sub> (km)	Site Class (EC8)	Comp.	PGA (cm/s <sup>2</sup> )	PGV (cm/s)	PGD (cm)	AI (m/s)	Dur 5-95 EW (sec)	CAV (m/s)
213	37.7967	37.9296		96.5		EW	172.19	33.57	12.65	0.69	7.72	6.05
						NS	244.17	52.45	20.22	1.03	7.71	7.54
						UD	195.96	23.08	9.15	0.45	7.71	4.61
1213	39.2310	40.4774		372.1		EW	330.38	20.93	3.08	0.80	4.12	6.89
						NS	244.56	11.69	1.69	0.45	8.40	5.90
						UD	185.15	4.58	0.86	0.23	7.07	4.17
2302	38.3923	39.6754	907	261.7	A	EW	215.96	9.93	1.67	0.26	9.97	5.09
						NS	199.81	7.63	1.15	0.20	11.98	4.76
						UD	112.06	5.02	1.57	0.08	21.59	3.87
2308	38.4506	39.3102	450	237.3	B	EW	163.86	22.92	5.45	0.34	36.63	8.02
						NS	314.07	26.57	5.49	0.59	20.49	9.03
						UD	356.06	7.53	1.53	0.33	12.24	5.83
3115	36.5463	36.1646	424	113.6	B	EW	81.75	6.45	1.60	0.16	24.86	4.63
						NS	137.39	14.30	2.42	0.33	24.70	6.36
						UD	134.77	6.55	0.94	0.18	26.88	4.32
3123	36.2142	36.1597	470	143.0	B	EW	574.78	82.84	20.13	7.14	16.93	31.00
						NS	629.02	167.80	43.45	8.89	12.71	33.25
						UD	833.04	48.19	14.77	4.44	14.38	23.44
3124	36.2387	36.1722	283	140.1	C	EW	622.65	79.06	21.02	7.22	19.22	32.42
						NS	556.34	107.25	35.98	5.82	21.57	30.17
						UD	564.23	29.97	8.76	3.00	17.08	18.97
3131	36.1912	36.1633	567	145.0	B	EW	350.96	43.98	12.45	1.61	7.64	11.31
						NS	354.34	39.39	6.57	1.26	8.16	9.51
						UD	145.35	18.15	5.36	0.34	14.30	5.92
3132	36.2067	36.1716	377	143.1	B	EW	513.00	49.36	10.01	4.24	17.56	23.58
						NS	498.87	67.08	15.36	3.60	13.43	21.48
						UD	333.33	35.94	8.25	1.75	13.69	14.68
3136	36.1159	36.2472	344	148.4	C	EW	363.82	40.81	7.88	3.44	32.97	25.66
						NS	516.50	49.72	11.27	3.77	27.82	25.39
						UD	212.01	22.07	6.28	1.05	31.31	14.06
3137	36.6929	36.4885	688	82.5	B	EW	714.51	45.64	18.48	3.52	16.52	21.45
						NS	412.31	49.04	12.26	3.43	17.09	21.81
						UD	448.07	34.11	9.05	2.18	16.71	17.20
3139	36.5838	36.4144	272	96.2	C	EW	475.23	94.80	30.18	6.68	29.67	31.73
						NS	557.22	127.92	47.94	8.21	37.07	36.39
						UD	328.16	49.91	14.82	2.80	15.33	20.03
3142	36.4980	36.3661	539	106.5	B	EW	730.50	48.94	13.15	5.61	11.95	25.35
						NS	640.58	62.41	10.74	5.31	11.49	23.84
						UD	412.74	21.59	4.27	1.84	13.14	15.04

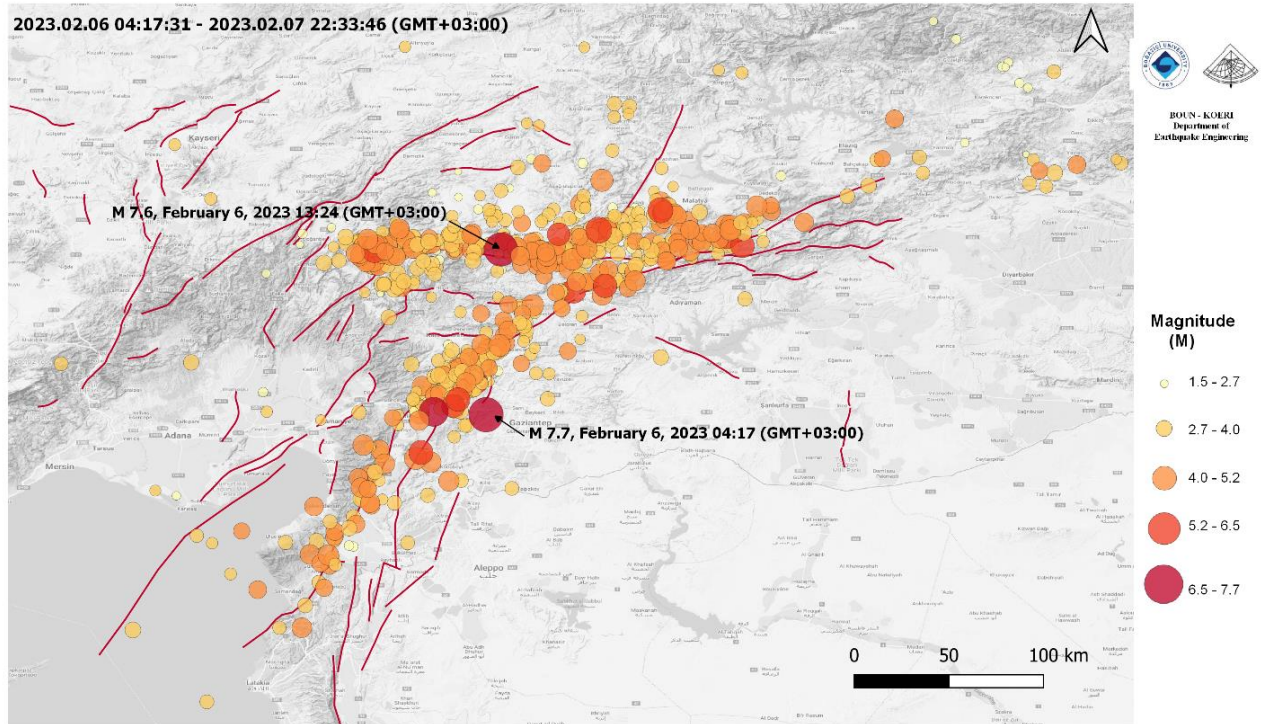
ID	Lat.	Lon.	Vs30 (m/s)	R <sub>epi</sub> (km)	Site Class (EC8)	Comp.	PGA (cm/s <sup>2</sup> )	PGV (cm/s)	PGD (cm)	AI (m/s)	Dur 5-95 EW (sec)	CAV (m/s)
3144	36.7569	36.4857	485	77.0	B	EW	779.18	54.53	28.12	3.47	41.68	24.61
						NS	564.00	59.66	13.56	3.36	33.42	21.19
						UD	465.47	62.19	21.05	1.27	16.50	12.09
3145	36.6454	36.4064	533	91.1	B	EW	694.72	97.38	31.06	6.20	11.30	22.81
						NS	617.10	56.16	20.09	3.64	13.84	20.21
						UD	585.57	58.57	16.92	2.93	10.53	16.64
3146	36.4908	36.2270		114.6		EW	317.18	27.55	7.17	2.90	16.99	18.10
						NS	448.17	22.61	6.85	4.35	16.82	21.47
						UD	253.10	15.68	4.80	1.48	17.76	13.52
4611	37.7472	37.2843	731	55.3	B	EW	312.54	34.70	7.87	2.42	44.01	22.23
						NS	327.28	29.99	6.64	2.63	43.13	22.95
						UD	162.42	10.22	2.39	0.69	47.99	12.23
4615	37.3868	37.1380	484	13.8	B	EW	556.63	111.20	24.18	5.78	47.10	31.95
						NS	580.24	75.61	22.11	5.42	46.86	30.79
						UD	658.44	46.61	9.57	2.75	35.99	19.93
4620	37.5857	36.8985	484	41.3	B	EW	313.00	23.79	9.12	2.49	43.89	21.83
						NS	296.32	21.22	5.37	2.21	42.10	20.18
						UD	174.21	9.76	2.33	1.03	46.75	14.72
4624	37.5361	36.9177	280	29.7	C	EW	312.52	44.23	13.68	4.29	45.85	29.28
						NS	339.40	41.39	13.34	3.77	46.05	27.10
						UD	152.14	24.28	4.80	1.06	43.82	14.75
4629	37.2874	36.7887	382	22.5	C	EW	246.73	17.51	3.16	1.34	10.38	8.70
						NS	337.84	27.84	4.61	2.02	9.73	10.41
						UD	121.93	6.47	1.72	0.24	12.53	3.98
4632	37.2560	36.7737	428	24.1	B	EW	282.83	31.60	7.22	1.48	9.90	9.38
						NS	349.34	43.02	8.07	2.09	9.36	10.52
						UD	186.63	11.77	1.91	0.57	12.00	6.11
NAR	37.3919	37.1574		15.4		EW	542.49	66.94	23.60	3.14	44.93	23.35
						NS	627.41	62.44	18.16	3.42	40.48	23.44
						UD	349.40	32.06	11.76	1.70	36.44	16.49



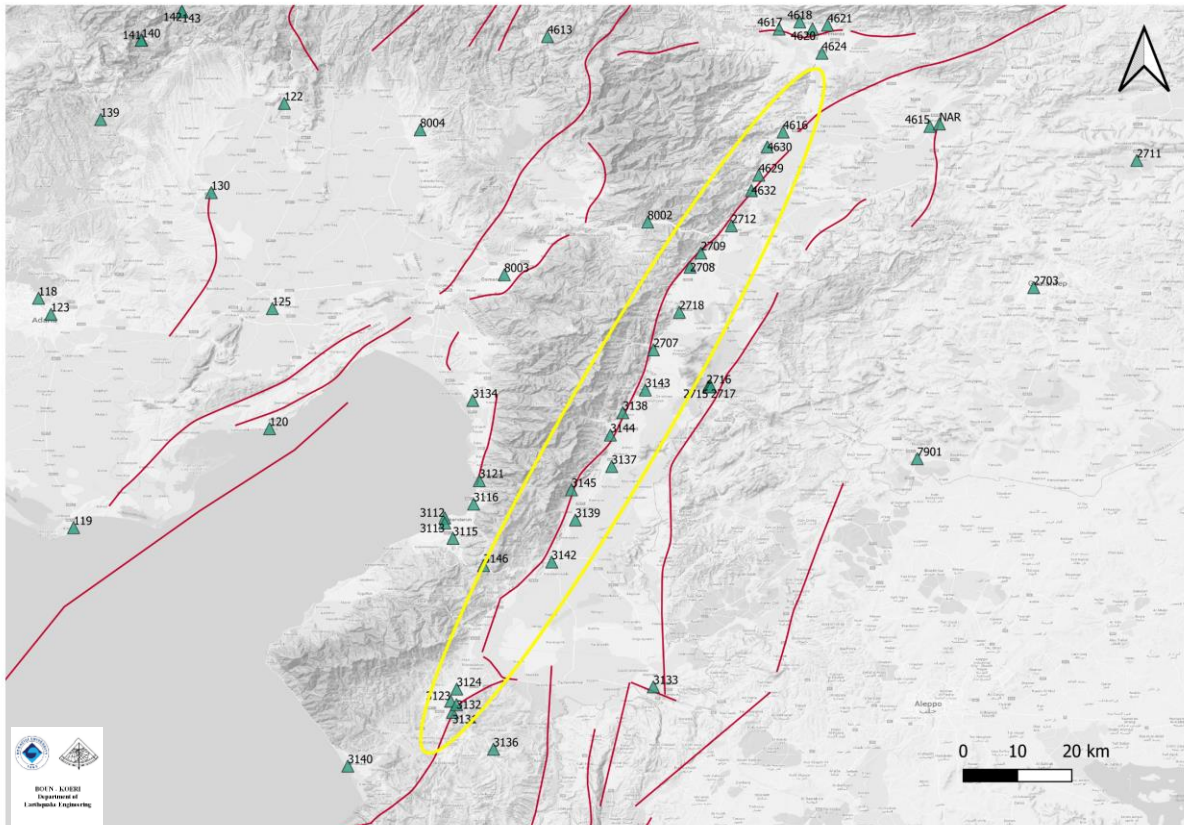
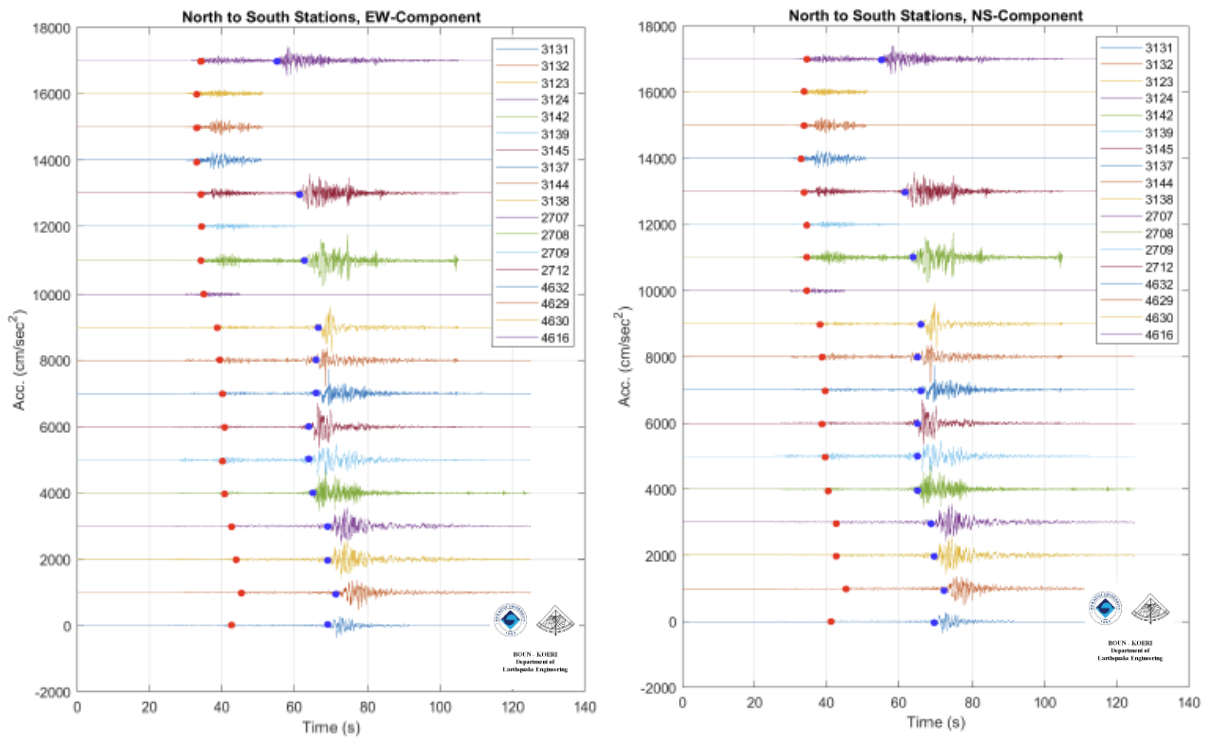
The yellow stars correspond to the epicenters of the **M 7.7 Kahramanmaraş – Gaziantep** and **M 7.6 Ekinözü – Kahramanmaraş** Earthquakes occurred on 6 February 2023. AFAD stations are shown with green triangles. Red lines represent the faults compiled from Active Fault Maps of Turkey, MTA (Mineral Research & Exploration General Directorate).



AFAD stations' PGA values from of the **M 7.7 Kahramanmaraş – Gaziantep** Earthquake. Red lines represent the faults compiled from Active Fault Maps of Turkey, MTA (Mineral Research & Exploration General Directorate).

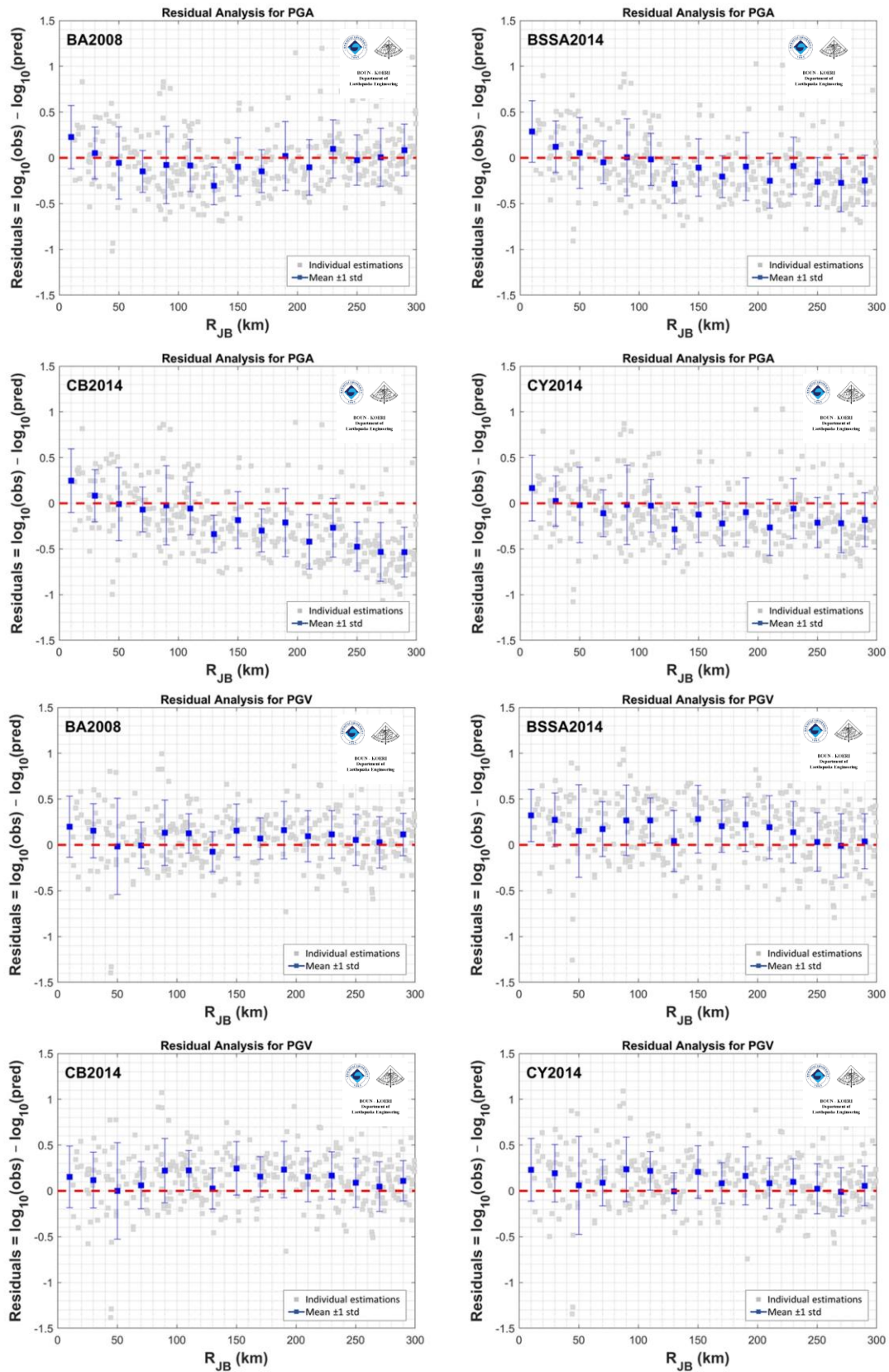


Aftershock activity. Data taken from KOERI (<http://www.koeri.boun.edu.tr/sismo/2/en/>). Red lines represent the faults compiled from Active Fault Maps of Turkey, MTA (Mineral Research & Exploration General Directorate).



Acceleration records of the stations on the Amanos segment (within the yellow ellipse) from SW to NE. Red lines represent the faults compiled from Active Fault Maps of Turkey, MTA (Mineral Research & Exploration General Directorate).





PGA and PGV residual analyses to investigate predictive capacity of four GMPEs for the M7.7, M7.6 and M6.6 (6 Feb 2023) earthquakes.

6 February 2023 (04:17) Kahramanmaraş-Türkiye M7.7 Earthquake

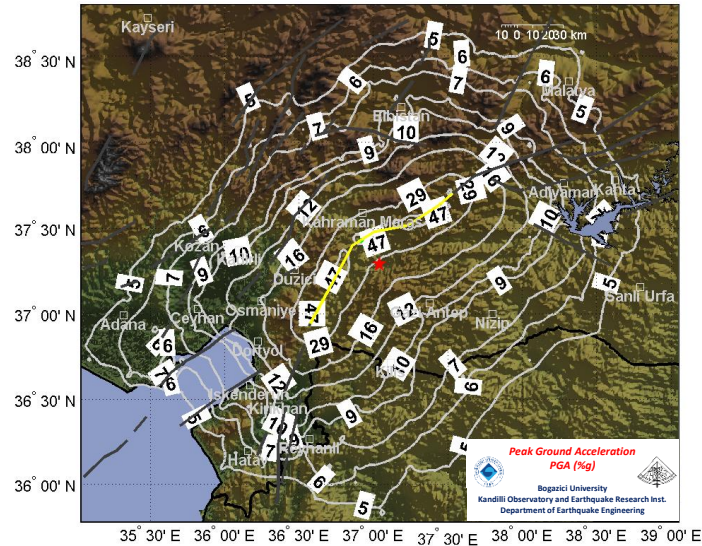
Preliminary Report (v4)

## PGA MAPS

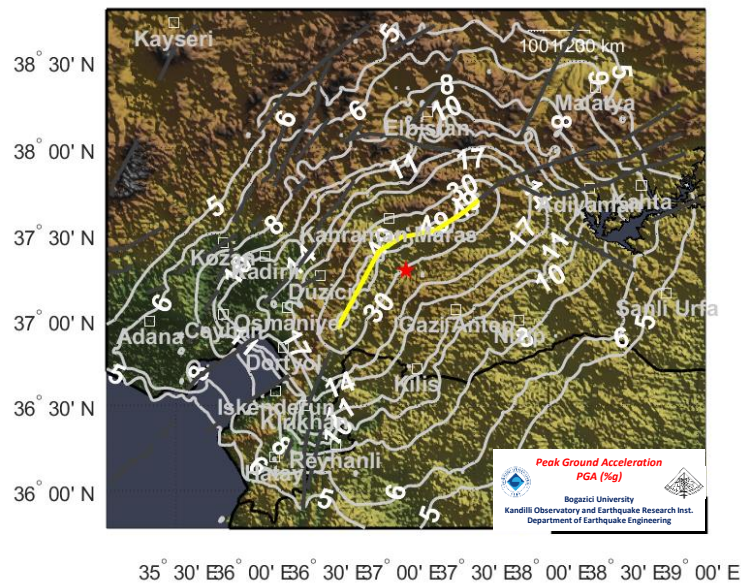
Associated fault line automatically chosen from the fault database. Ground motion estimations done without recorded data.

**GMPE: CY2008** Computed values ranging between 0.011g and 0.66g (min. and max. computed values might not be visible on the contour map).

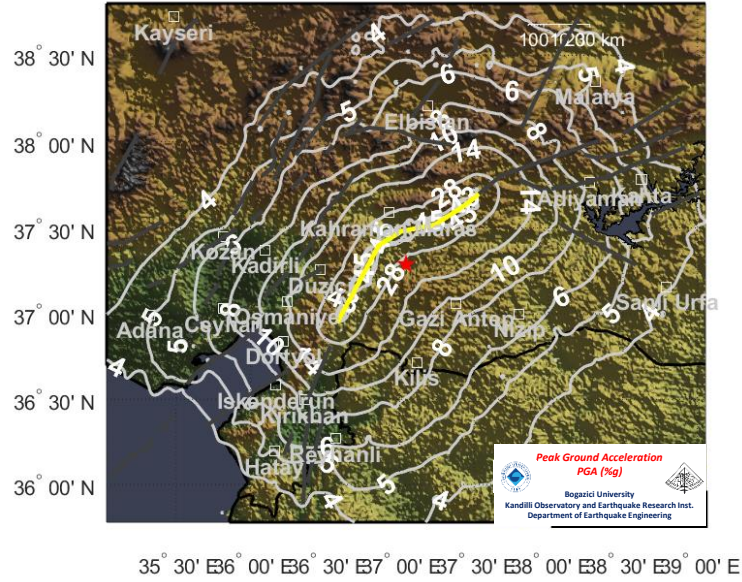
M7.7 Depth= 8.6 Lat= 37.288 Lon= 37.043  
Map of: PGA (%)



**GMPE: CY2014** Computed values ranging between 0.014g and 0.69g (min. and max. computed values might not be visible on the contour map).



**GMPE: ASB2014** Computed values ranging between 0.019g and 0.55g (min. and max. computed values might not be visible on the contour map).

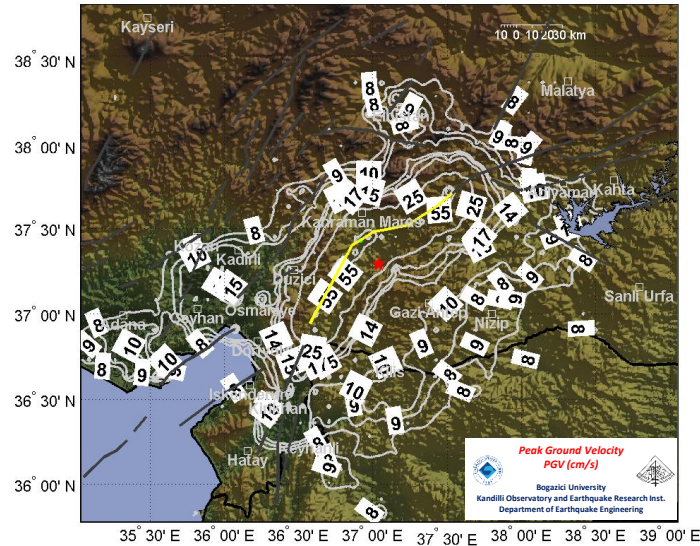


## PGV MAPS

Associated fault line automatically chosen from the fault database. Ground motion estimations done without recorded data.

**GMPE: CY2008** Computed values ranging between 2.2cm/s and 84cm/s (min. and max. computed values might not be visible on the contour map).

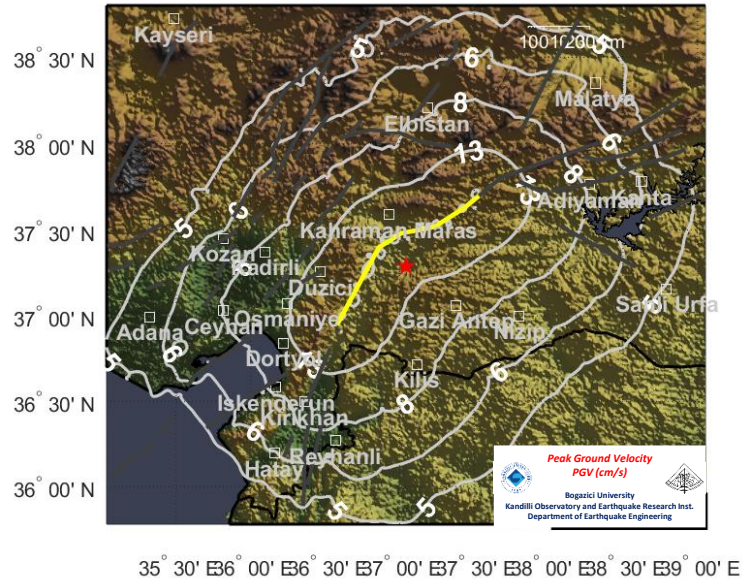
M7.7 Depth= 8.6 Lat= 37.288 Lon= 37.043  
Map of: PGV (cm/s)



**GMPE: CY2014** Computed values ranging between 2.8cm/s and 88cm/s (min. and max. computed values might not be visible on the contour map).



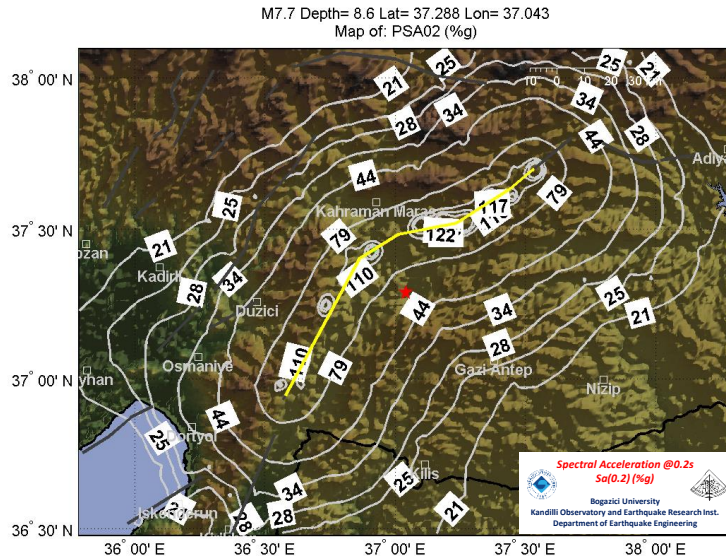
**GMPE: ASB2014** Computed values ranging between 2.9cm/s and 38cm/s (min. and max. computed values might not be visible on the contour map).



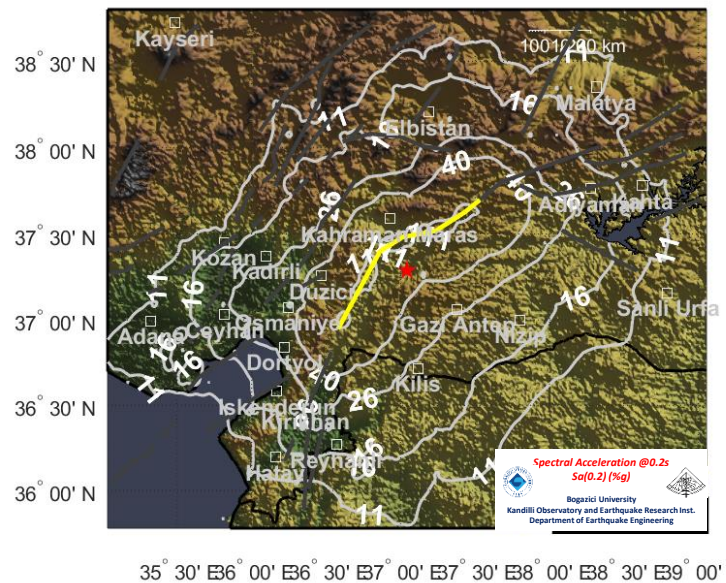
## Sa(0.2s) MAPS

Associated fault line automatically chosen from the fault database. Ground motion estimations done without recorded data.

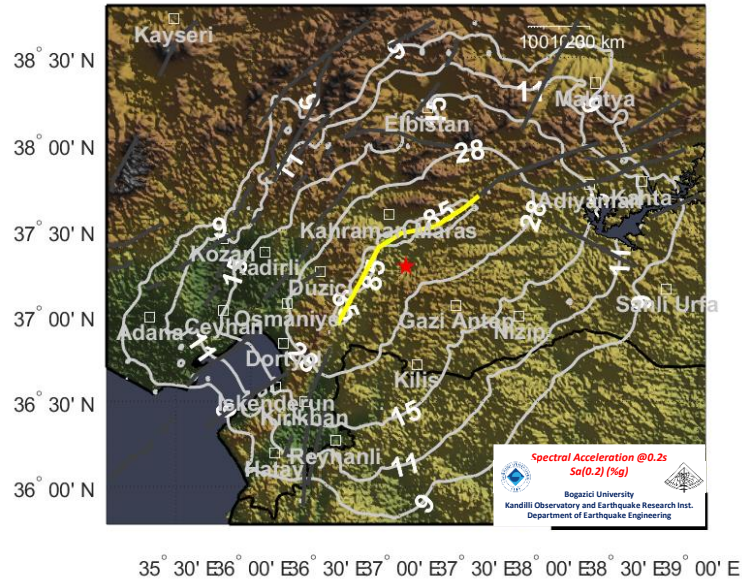
**GMPE: CY2008** Computed values ranging between 0.027g and 1.68g (min. and max. computed values might not be visible on the contour map).



**GMPE: CY2014** Computed values ranging between 0.02g and 1.60g (min. and max. computed values might not be visible on the contour map).



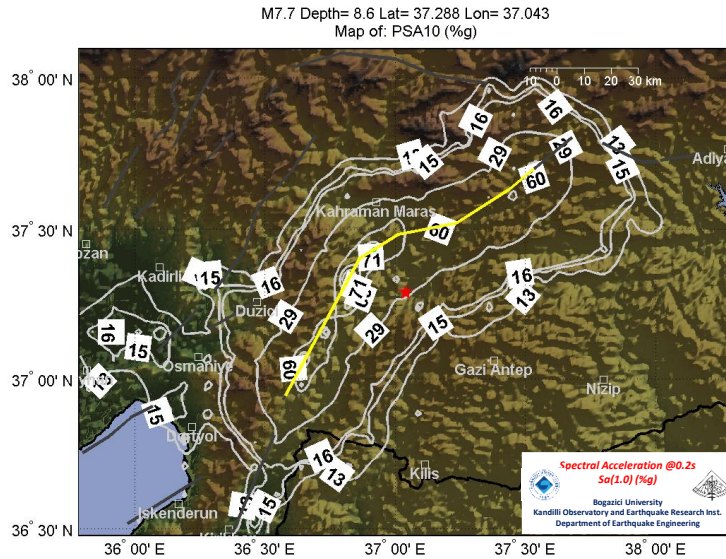
**GMPE: ASB2014** Computed values ranging between 0.034g and 1.14g (min. and max. computed values might not be visible on the contour map).



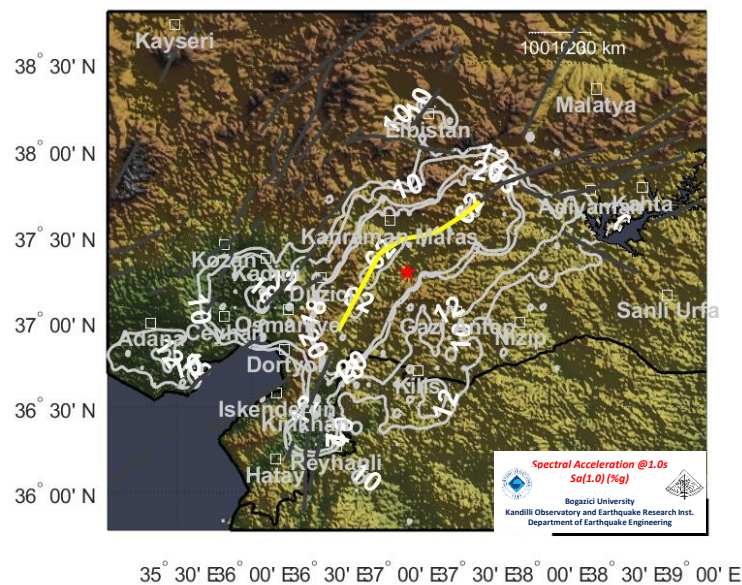
## Sa(1.0s) MAPS

Associated fault line automatically chosen from the fault database. Ground motion estimations done without recorded data.

**GMPE: CY2008** Computed values ranging between 0.024g and 0.89g (min. and max. computed values might not be visible on the contour map).

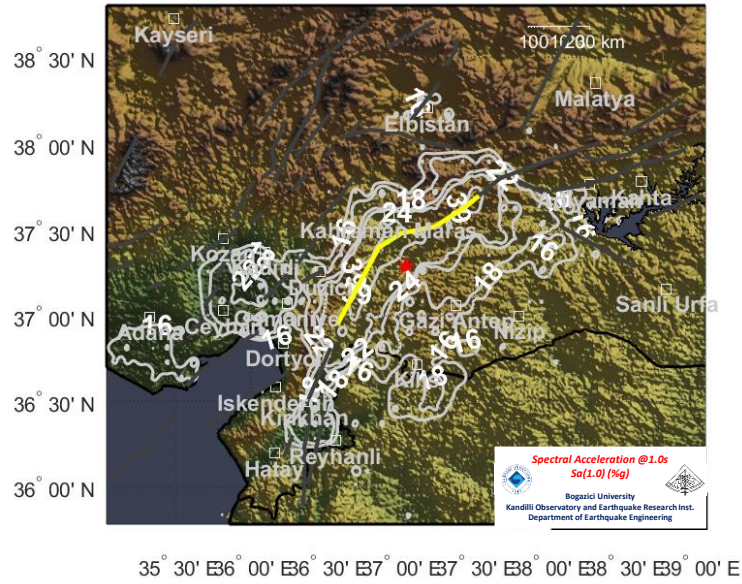


**GMPE: CY2014** Computed values ranging between 0.015g and 1.08g (min. and max. computed values might not be visible on the contour map).





**GMPE: ASB2014** Computed values ranging between 0.043g and 0.59g (min. and max. computed values might not be visible on the contour map).



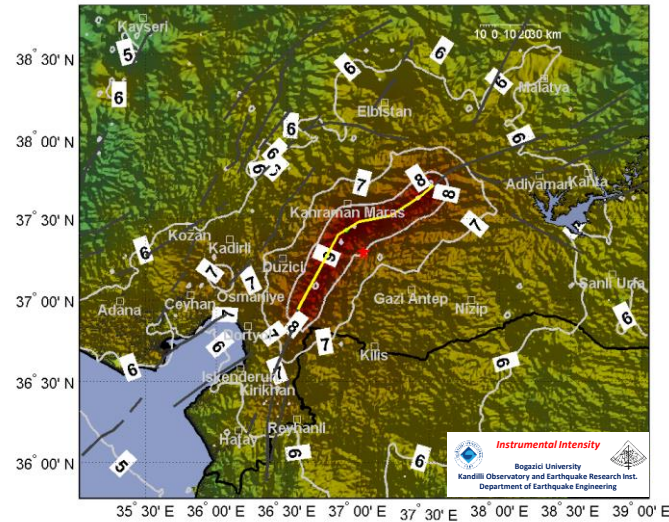
## INTENSITY MAPS

Associated fault line automatically chosen from the fault database. Ground motion estimations done without recorded data.

**GMPE : CY2008**

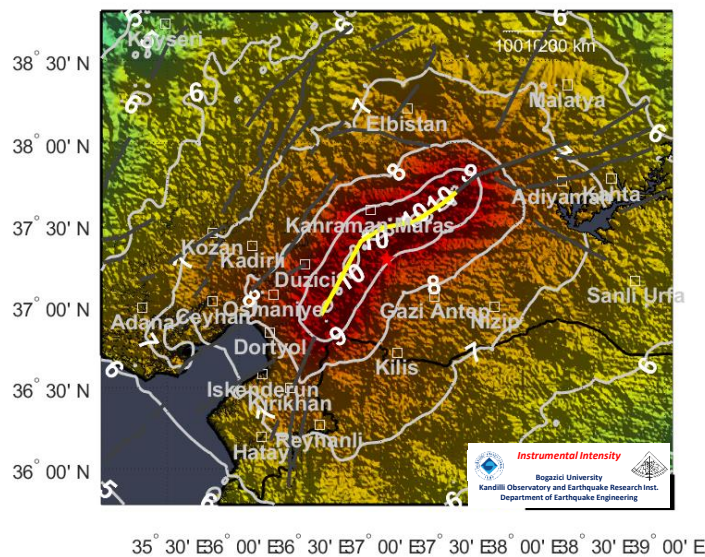
**Intensity Equation : AK2007** Computed values ranging between 4.8 and 9.4 (min. and max. computed values might not be visible on the contour map).

M7.7 Depth= 8.6 Lat= 37.288 Lon= 37.043  
Map of: INTENS



**GMPE : CY2014**

**Intensity Equation : BA2014** Computed values ranging between 4.4 and 10.6 (min. and max. computed values might not be visible on the contour map).

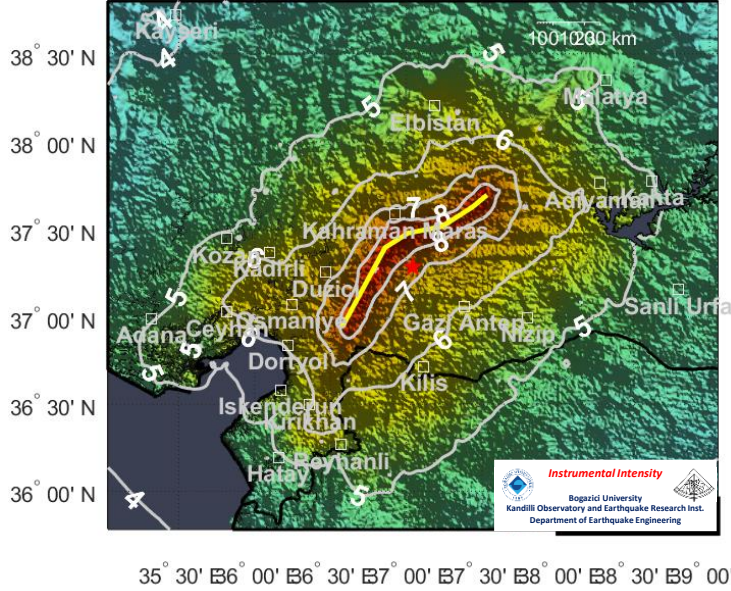


6 February 2023 (04:17) Kahramanmaraş-Türkiye M7.7 Earthquake

Preliminary Report (v4)

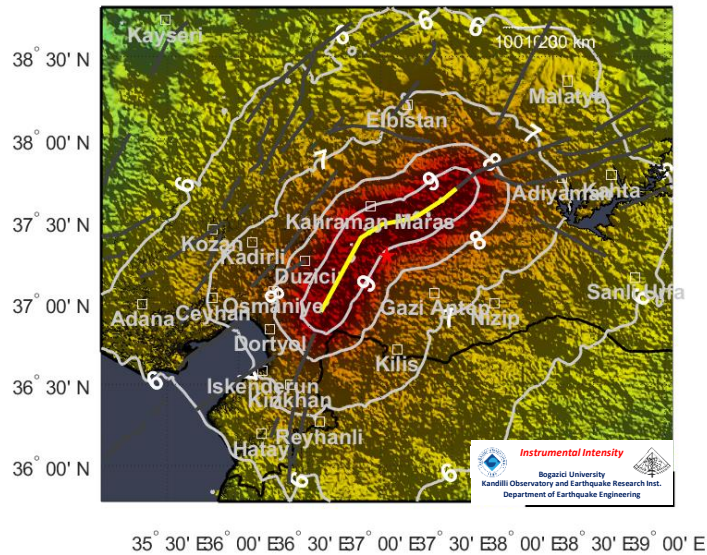
**GMPE : CY2014**

**Intensity Equation : WQHK1999** Computed values ranging between 3.5 and 9.1 (min. and max. computed values might not be visible on the contour map).



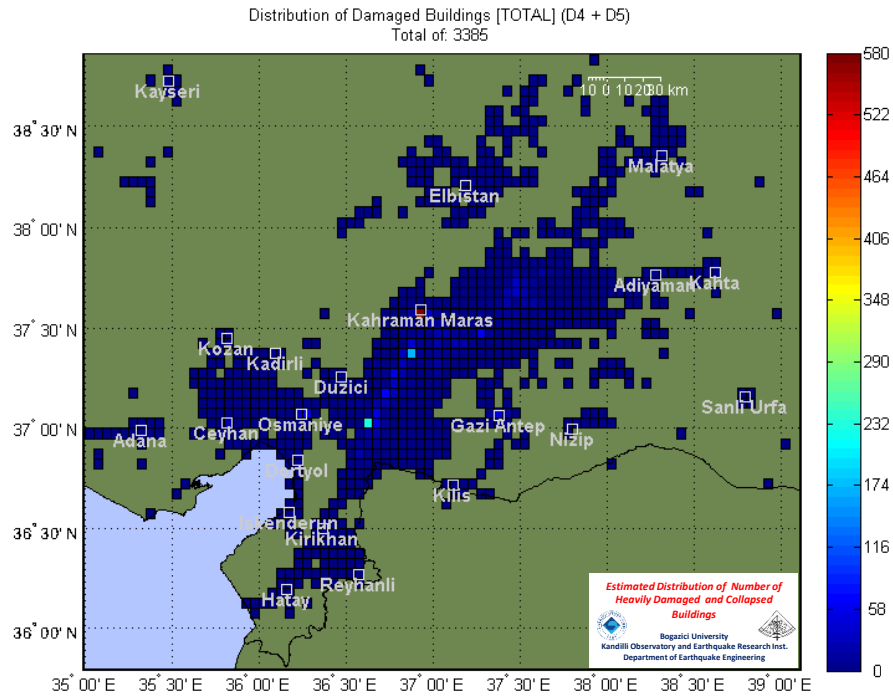
**GMPE : ASB2014**

**Intensity Equation : BA2014** Computed values ranging between 4.9 and 10.2 (min. and max. computed values might not be visible on the contour map).



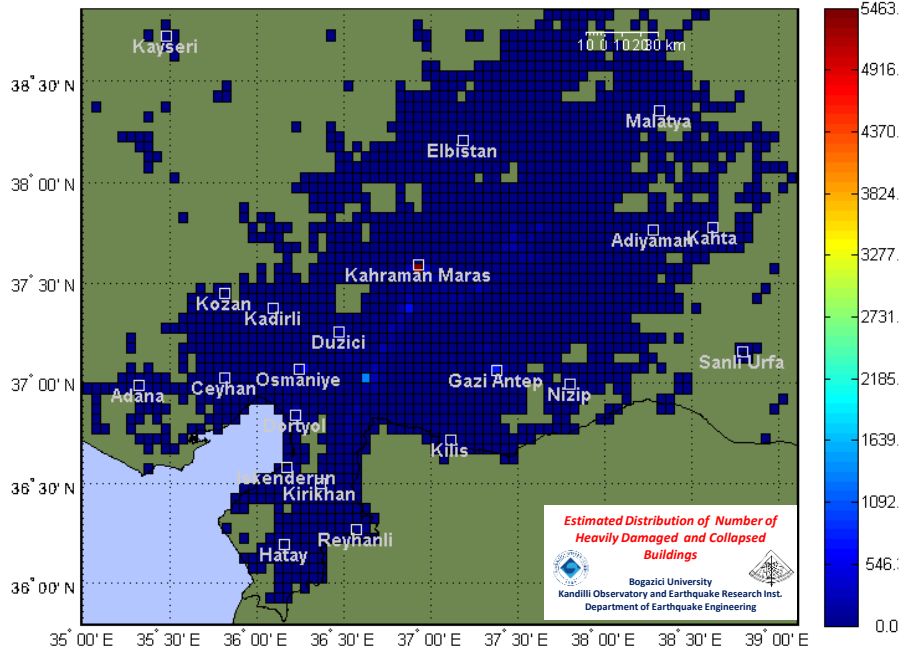
# INTENSITY BASED ESTIMATION of BUILDING DAMAGE DISTRIBUTION (REGIONAL SCALE)

GMPE : CY2008  
Intensity Equation : AK2007

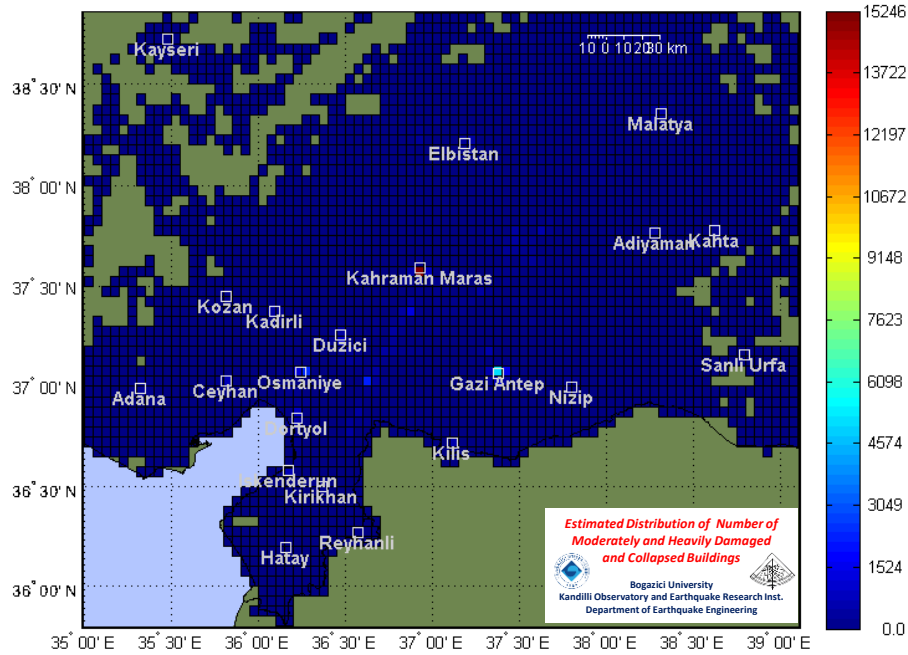


**GMPE : CY2014**  
**Intensity Equation : BA2014**

Distribution of Damaged Buildings [TOTAL] (D4 + D5)  
 Total of: 25711

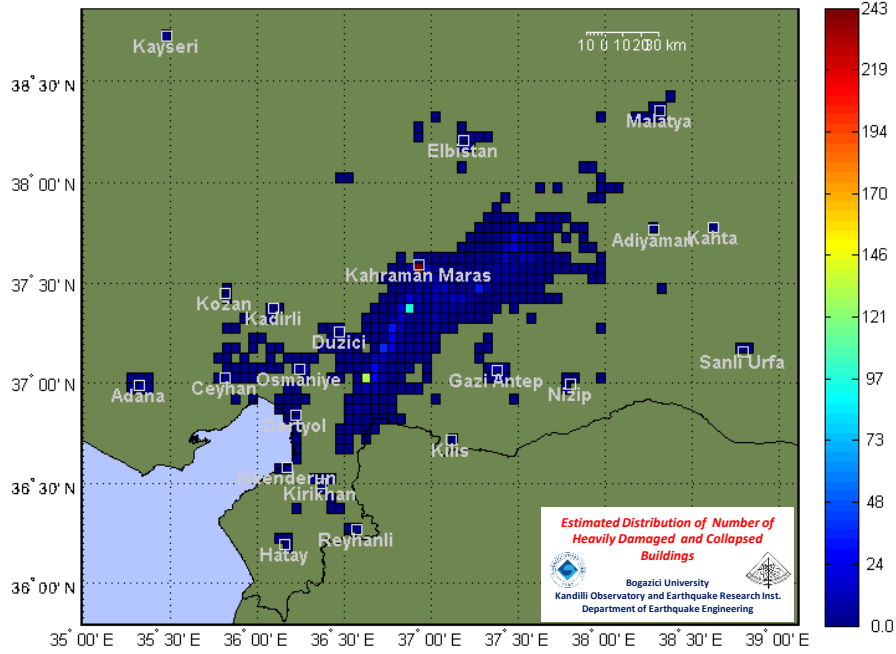


Distribution of Damaged Buildings [TOTAL] (D3 + D4 + D5)  
 Total of: 87094

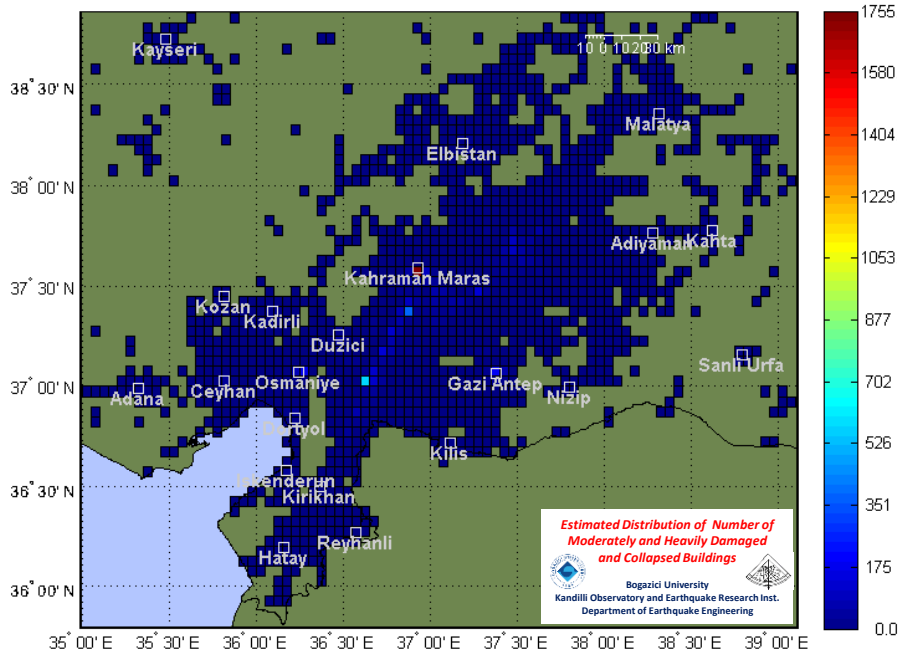


**GMPE : CY2014**  
**Intensity Equation : WQHK1999**

Distribution of Damaged Buildings [TOTAL] (D4 + D5)  
Total of: 1547

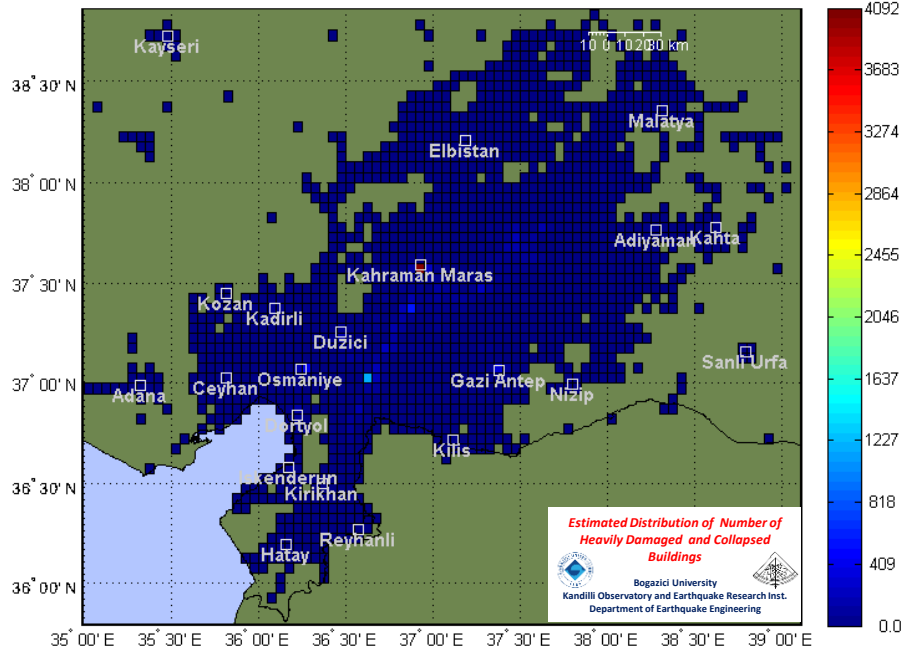


Distribution of Damaged Buildings [TOTAL] (D3 + D4 + D5)  
Total of: 9057

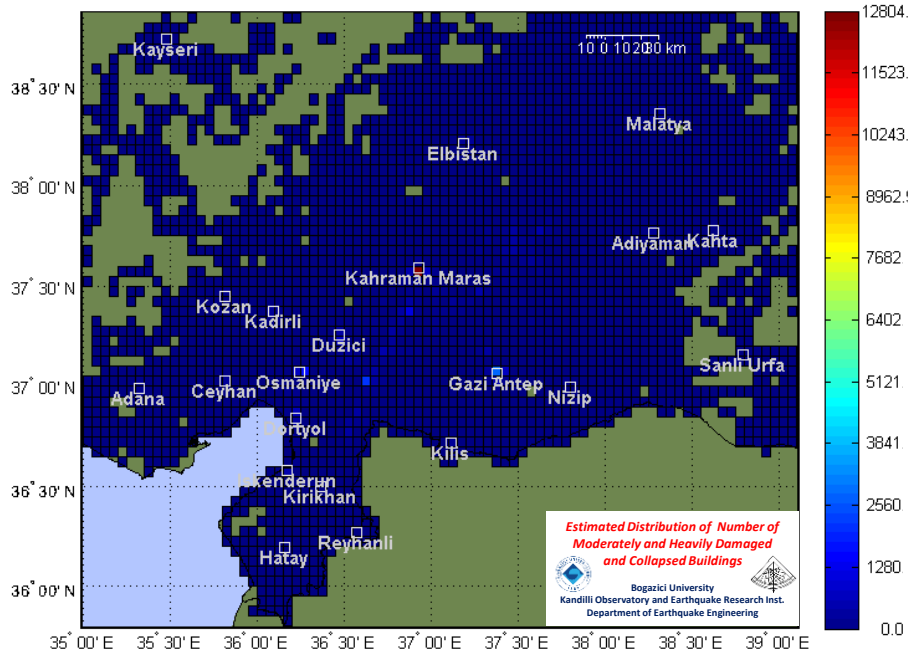


**GMPE : ASB2014**  
**Intensity Equation : BA2014**

Distribution of Damaged Buildings [TOTAL] (D4 + D5)  
Total of: 18280



Distribution of Damaged Buildings [TOTAL] (D3 + D4 + D5)  
Total of: 62938



## SPECTRAL ACCELERATION-DISPLACEMENT BASED ESTIMATION of BUILDING DAMAGE DISTRIBUTION for KAHRAMANMARAS CITY

**It is estimated that approximately 40% of the city's building inventory in (moderate+extensive+complete) damage state.**

### Modified Acceleration-Displacement Response Spectrum (MADRS) Method

Damage State	Ground Motion Input			Average	% of total number of buildings
	CY2008	ASB2014	CY2014		
<b>Complete</b>	725	652	1415	<b>931</b>	<b>2%</b>
<b>Extensive</b>	3396	3069	5234	<b>3900</b>	<b>9%</b>
<b>Moderate</b>	11780	11330	14018	<b>12376</b>	<b>27%</b>
<b>Slight</b>	13387	13374	12943	<b>13235</b>	<b>29%</b>
<b>None</b>	16511	17373	12189	<b>15358</b>	<b>34%</b>

### Capacity Spectrum Method (CSM)

Damage State	Ground Motion Input			Average	% of total number of buildings
	CY2008	ASB2014	CY2014		
<b>Complete</b>	1584	1563	3428	<b>2192</b>	<b>5%</b>
<b>Extensive</b>	4498	4909	7406	<b>5604</b>	<b>12%</b>
<b>Moderate</b>	11681	12885	12698	<b>12421</b>	<b>27%</b>
<b>Slight</b>	11867	12329	9826	<b>11341</b>	<b>25%</b>
<b>None</b>	16168	14112	12440	<b>14240</b>	<b>31%</b>

### Displacement Coefficient Method (DCM)

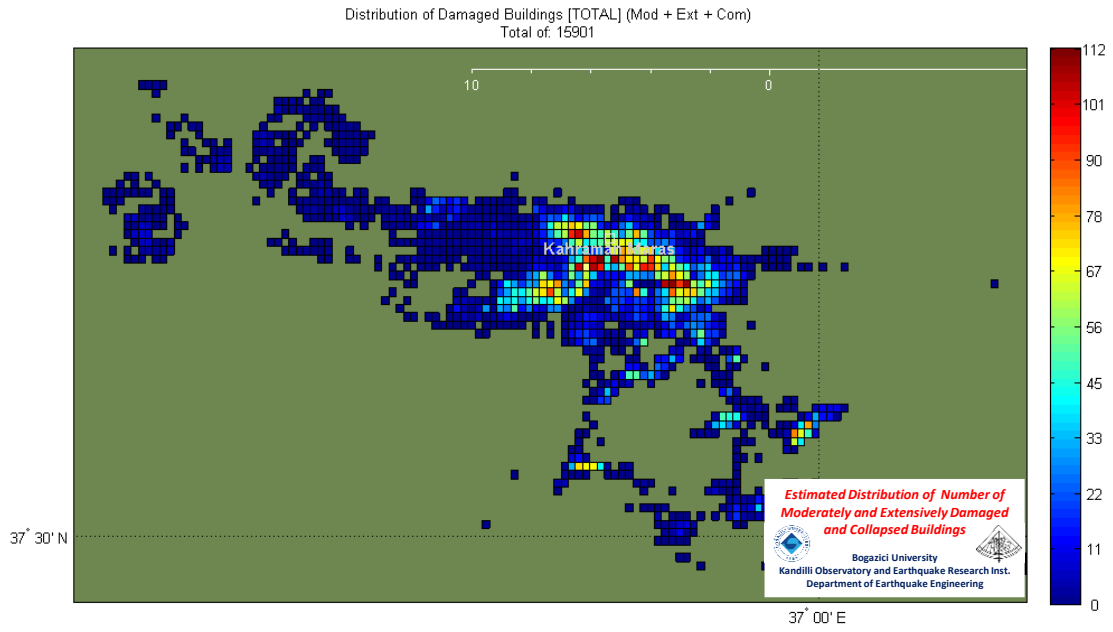
Damage State	Ground Motion Input			Average	% of total number of buildings
	CY2008	ASB2014	CY2014		
<b>Complete</b>	744	456	1060	<b>753</b>	<b>2%</b>
<b>Extensive</b>	3785	2613	4782	<b>3727</b>	<b>8%</b>
<b>Moderate</b>	12882	10913	14192	<b>12662</b>	<b>28%</b>
<b>Slight</b>	13816	13825	13540	<b>13727</b>	<b>30%</b>
<b>None</b>	14571	17991	12224	<b>14929</b>	<b>33%</b>

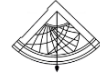
Spatial distributions of the number of damaged buildings from MADRS method presented in the following maps.





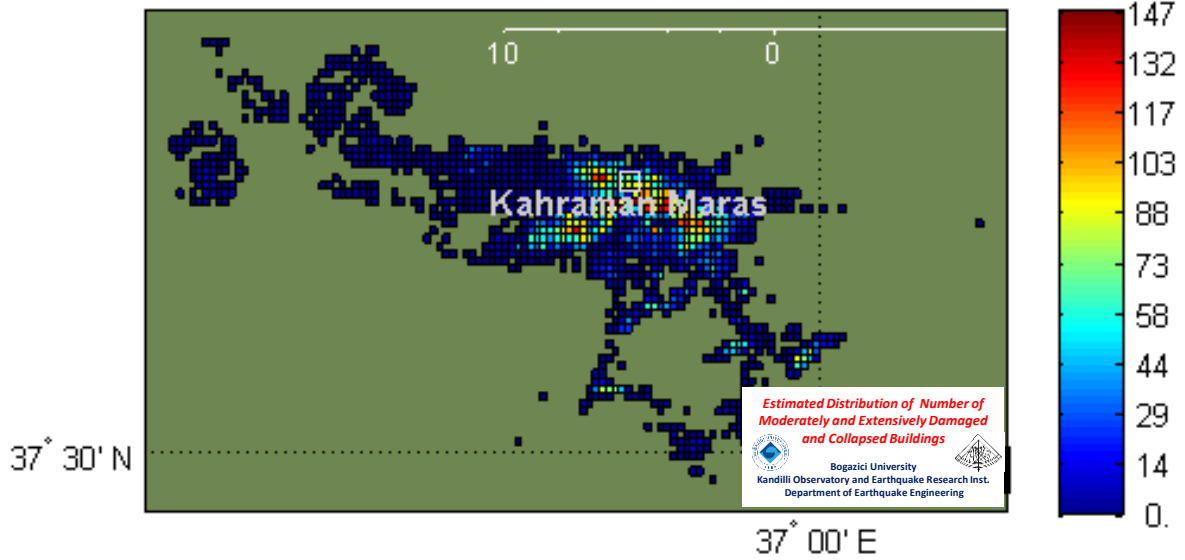
## GMPE: CY2008



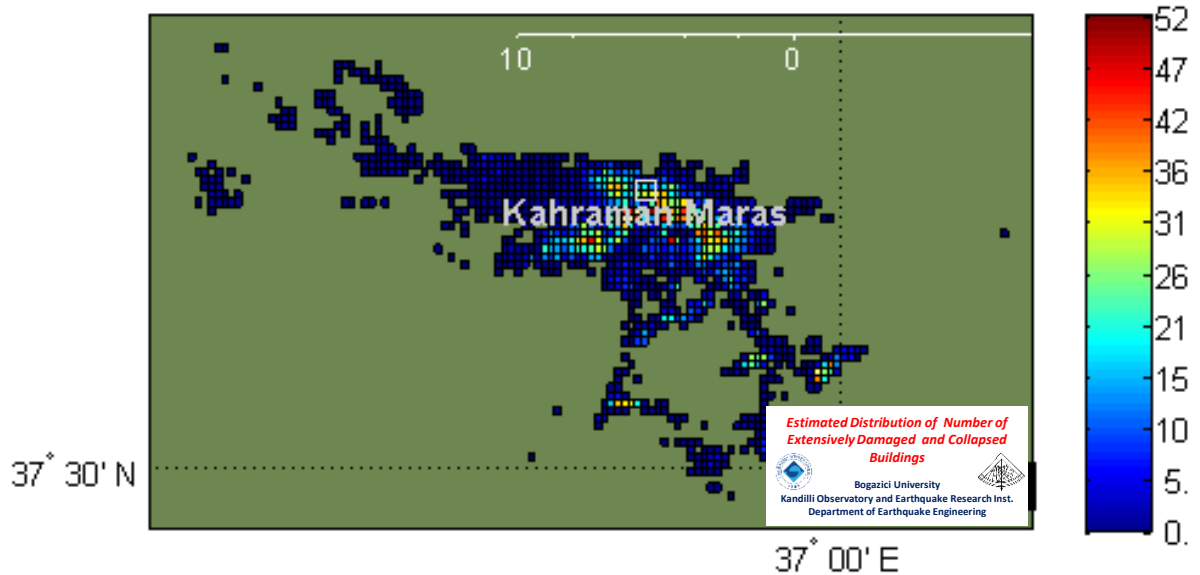


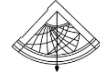
## GMPE: CY2014

Distribution of Damaged Buildings [TOTAL] (Mod + Ext + Com)  
Total of: 20667



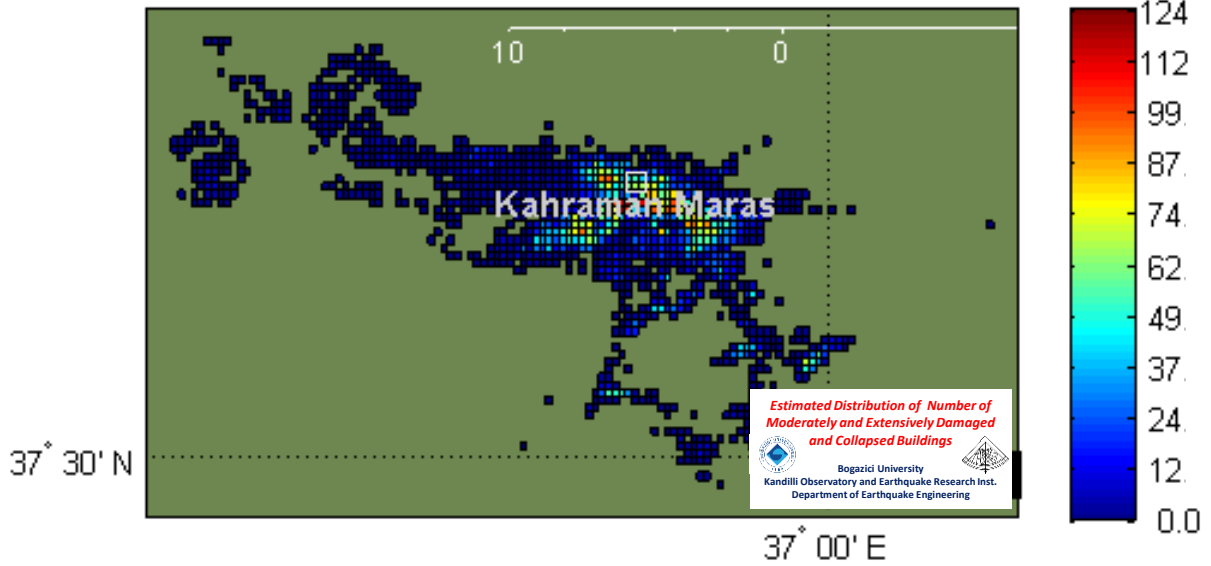
Distribution of Damaged Buildings [TOTAL] (Ext + Com)  
Total of: 6649



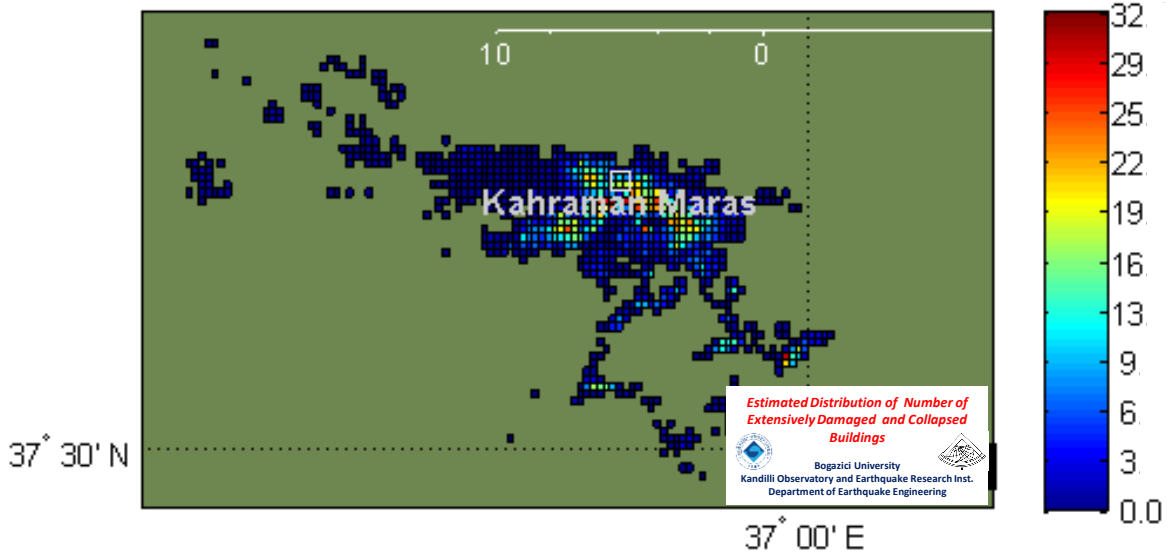


## GMPE: ASB2014

Distribution of Damaged Buildings [TOTAL] (Mod + Ext + Com)  
Total of: 15051



Distribution of Damaged Buildings [TOTAL] (Ext + Com)  
Total of: 3721



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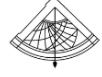
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