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Characteristics of tsunami source regions in Marmara

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MARSite (GA 308417) D5.6 Characteristics of Tsunami Source regions in Marmara

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1. Introduction

This short deliverable is associated with the Task 4 of WP5 where the main goal is to build up a detailed scenario database for all possible earthquakes in the Marmara Sea with a tsunamigenic potential. The main purpose of this deliverable is to identify a set of earthquake scenarios for the whole Marmara Region, which will constitute the basis for D5.7 “Tectonic origin tsunami scenario database for the Marmara Region (M36).”

Due to the very short travel times in Marmara Sea, a Tsunami Early Warning System (TEWS) cannot rely on real-time calculations and has to be based on a pre-computed tsunami scenario database to be queried in real-time, basing on the initial determination of earthquake hypocentre and Magnitude, but also on dislocation models calculated from real-time inversion of geodetic and seismic data similarly to e.g. the GI-TEWS in Indonesia. Such a database could be inspired to that implemented in the Japanese TEWS, which nonetheless will be adapted to Marmara region. Initially, it was decided to divide the Marmara region in grid areas of fixed size $0.1^{\circ} \times 0.1^{\circ}$ and to develop tsunami scenarios for each bin, where the bin centre will be characterized as the epicentre location. Earthquake source parameters would have been defined based on a study of characteristic source parameters in the region, supported with historical and statistical studies. This suggested methodology was successfully used for the Eastern Mediterranean, Aegean and Black Seas (Necmioglu and Ozel, 2015). However, the difference in the spatial scale and lack of instrumentally recorded major tsunamigenic earthquakes in Marmara (excluding 1999 Izmit earthquake), led to the conclusion that it would be a better approach deviate from this initial methodology and base the foreseen work on the progress made in WP7 and internally submitted deliverables D7.2 “GIS Database of the fault parameters” and D7.4 “Revisited historical earthquake catalogue”, it was decided to base the work for the Deliverable 5.6 on those WP7 deliverables. To support, an extensive review of the literature (Sengor et al. (2014), Armijo et al. (2005), Alpar and Yalçınrak (2002), Imren et al. (2001), Oglesby and Mai (2012), Ergintav et al. (2014), Kaneko (2009), Hebert et al. (2005), Gasperini et al. (2011), Uykucu et al. (2009), Tinti et al. (2006), Hergert and Heidbach (2010), Hergert et al. (2011), Le Pichon et al. (2001), Le Pichon et al. (2003), Le Pichon et al. (2014), Altınok and Alpar (2006)) has taken place, and in some cases, used primarily, such as the in the case of South Marmara Fault.

2. Fault Segments in Marmara to be used in tectonic origin tsunami modelling

Based on the database provided, simplified fault segments have been identified, where each segment correspond to a rectangular area with an associated uniform slip (Figure 1). All parameters required for the identification of the segments, such as geographical coordinates for the start- and end-points of the segments, hypocentre, type of

fault, strike, dip, rake, length and width of the segment, focal depth (where the top of the fault has been set to 0.5 km depth), corresponding displacements according to empirical relations provided by Leonard (2010) and Wells and Coppersmith (1994), are provided in Table 1. 30 different scenarios have been identified and described in Table 2.



Figure 1: Simplified fault segments in Marmara identified for tsunami modelling. Segments correspond to a rectangular area with an associated uniform slip.

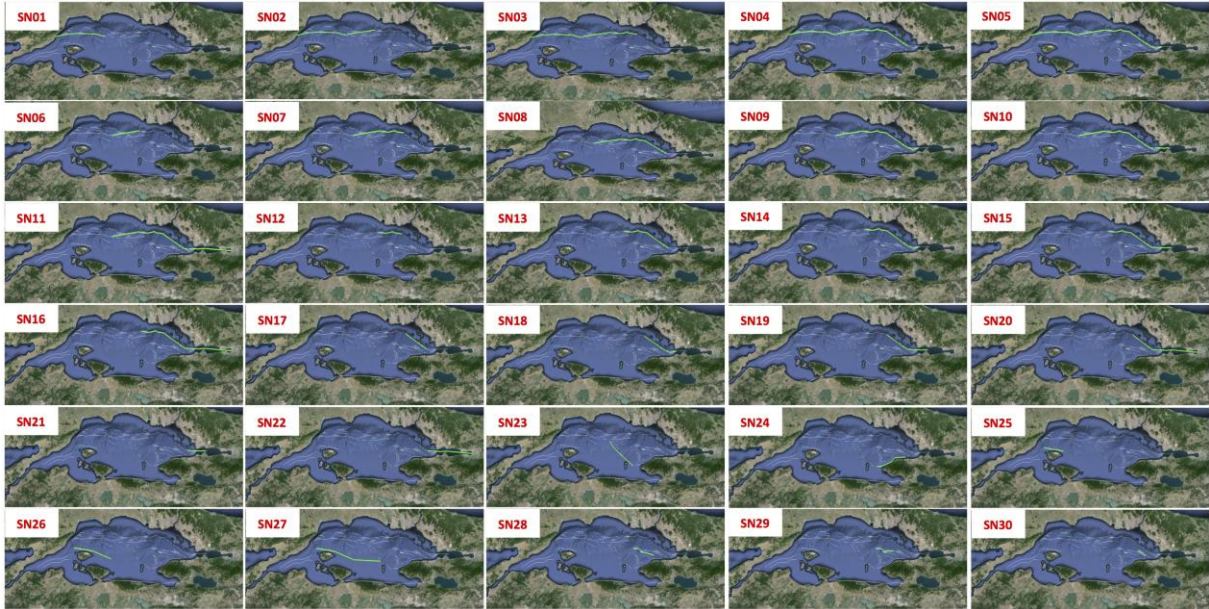


Figure 2: Map representation of the scenarios considered in this study.

FAULT SEGMENTS																					
Code	Name	Segment Information										L2010					WC1994				
		Start		End		Hypocenter		Fault Type	Strike	Dip	Rake	L (km)	W (km)	Segment Area (km ²)	Focal Depth (km)	D (m)	Mw	Moment (dyn-cm)	Dmax (m)	Mw(max)	Moment (dyn-cm)
LAT	LOE	LAT	LOE	LAT	LOE	LAT	LOE														
1	Ganos Tekirdag Basin	40,749964	27,33544	40,791196	27,524340	40,770580	27,429890	SSF	75	80	175	16,5	15	247,5	7,9	0,6	6,4	5,0119E+25	1,2	6,6	8,913E+25
2	Tekirdag Basin	40,790711	27,522927	40,812165	27,699464	40,801438	27,611196	SSF	81	80	175	15	15	225,0	7,9	0,6	6,3	3,5481E+25	1	6,5	7,079E+25
3	Western High	40,804949	27,682151	40,817149	27,942106	40,811049	27,812129	SSF	86	80	175	22	15	330,0	7,9	0,7	6,5	7,0795E+25	1,3	6,7	1,413E+26
4	Central Basin	40,814712	27,941471	40,791261	28,069561	40,802987	28,005516	NSSF	104	80	210	11	15	165,0	7,9	0,5	6,2	2,5119E+25	1,9	6,6	1E+26
5	Kumburgaz Basin	40,800851	28,076138	40,877451	28,500384	40,839151	28,288261	NSSF	77	80	210	36,5	15	547,5	7,9	0,9	6,7	1,4125E+26	4,5	7,2	7,943E+26
6	Main Marmara West	40,872793	28,494853	40,867647	28,633321	40,870220	28,564032	SSF	93	80	175	11,5	10	115,0	5,4	0,4	6,1	1,7783E+25	0,7	6,2	2,512E+25
7	Main Marmara Central	40,869222	28,633013	40,890768	28,745054	40,879995	28,689034	SSF	76	80	175	9,5	10	95,0	5,4	0,4	6,0	1,2589E+25	0,6	6,1	1,778E+25
8	Main Marmara East	40,880729	28,739289	40,872382	28,870848	40,876556	28,805069	SSF	95	80	175	11	10	110,0	5,4	0,4	6,0	1,2589E+25	0,7	6,2	2,512E+25
9	Princess Islands	40,867859	28,866965	40,724658	29,215052	40,796259	29,041009	NSSF	119	80	210	33,5	10	335,0	5,4	0,7	6,5	7,0795E+25	3,7	7,0	3,981E+26
10	Çınarcık Basin SE	40,727181	29,217116	40,712476	29,282602	40,719829	29,249859	SSF	107	80	175	5,5	12,5	68,8	6,7	0,3	5,8	6,3096E+24	1,1	6,2	2,512E+25
11	Izmit SW	40,710411	29,280333	40,731138	29,383716	40,720896	29,332025	SSF	75	80	175	9	12,5	112,5	6,7	0,4	6,0	1,2589E+25	0,7	6,2	2,512E+25
12	Izmit NW1	40,732373	29,216368	40,730504	29,289978	40,731439	29,253173	SSF	92	80	175	6	12,5	75,0	6,7	0,3	5,9	8,9125E+24	0,5	6,0	1,259E+25
13	Izmit NW2	40,728456	29,290416	40,735227	29,332225	40,731842	29,311321	SSF	78	80	175	3,5	12,5	43,8	6,7	0,2	5,6	3,1623E+24	0,4	5,8	6,31E+24
14	Izmit NW3	40,735559	29,332473	40,732837	29,42564	40,734198	29,379057	SSF	92	80	175	8	12,5	100,0	6,7	0,4	6,0	1,2589E+25	0,8	6,2	2,512E+25
15	Izmit W	40,733116	29,427631	40,74221	29,511088	40,737663	29,469360	SSF	82	80	175	7	12,5	87,5	6,7	0,3	5,9	8,9125E+24	0,6	6,1	1,778E+25
16	Izmit Gulf	40,742355	29,512603	40,735779	29,941363	40,739067	29,726983	SSF	91	80	175	36	12,5	450,0	6,7	0,8	6,6	1E+26	1,4	6,8	1,995E+26
17	Central High SW	40,777667	28,252181	40,702664	28,341253	40,740166	28,296717	NF	138	80	270	11	10	110,0	5,4	0,4	6,0	1,2589E+25	1,4	6,4	5,012E+25
18	Central High South	40,701628	28,343182	40,585403	28,562886	40,643516	28,453034	NF	125	80	270	22,5	10	225,0	5,4	0,6	6,4	5,0119E+25	2,7	6,8	1,995E+26
19	Central High SE	40,585305	28,566252	40,539502	28,655514	40,562404	28,610883	NF	125	80	270	9	10	90,0	5,4	0,4	6,0	1,2589E+25	1,2	6,3	3,548E+25
20	Armutlu SW	40,547013	28,683915	40,560881	28,778183	40,553947	28,731049	SSF	79	80	5	8	10	80,0	5,4	0,3	5,9	8,9125E+24	0,5	6	1,259E+25
21	Armutlu Central	40,562441	28,781652	40,617179	28,935797	40,589810	28,858725	SSF	65	80	5	14,5	10	145,0	5,4	0,4	6,2	2,5119E+25	0,8	6,3	3,548E+25
22	Armutlu NE	40,623231	28,930956	40,653124	28,960353	40,638178	28,945655	SSF	37	80	5	4	10	40,0	5,4	0,2	5,6	3,1623E+24	0,3	5,7	4,467E+24
23	Çınarcık W	40,654023	28,965627	40,669309	29,097213	40,661666	29,031420	SSF	81	80	5	11,5	10	115,0	5,4	0,4	6,1	1,7783E+25	0,7	6,2	2,512E+25
24	Çınarcık E	40,669257	29,096848	40,669719	29,139493	40,669488	29,118171	SSF	89	80	5	3,5	10	35,0	5,4	0,2	5,5	2,2387E+24	0,4	5,7	4,467E+24
25	Marmara Island	40,691415	27,462506	40,673965	27,77498	40,682690	27,618743	SSF	94	80	5	26,5	15	397,5	7,9	0,7	6,6	1E+26	1,5	6,8	1,995E+26
26	Southern Shelf West	40,670641	27,775437	40,609387	28,047487	40,640014	27,911462	SSF	107	80	5	24	15	360,0	7,9	0,7	6,5	7,0795E+25	1,2	6,7	1,413E+26
27	Southern Shelf East	40,606109	28,0512	40,614599	28,478857	40,610354	28,265029	SSF	89	80	5	36	15	540,0	7,9	0,9	6,7	1,4125E+26	1,6	6,9	2,818E+26
28	Çınarcık Basin SW	40,747678	28,66872	40,753416	28,756989	40,750547	28,712855	RSSF	85	80	30	7,5	10	75,0	5,4	0,3	5,9	8,9125E+24	1,0	6,2	2,512E+25
29	Çınarcık Basin S	40,751898	28,755589	40,713675	28,834093	40,732787	28,794841	NSSF	123	80	330	8	10	80,0	5,4	0,3	5,9	8,9125E+24	1,4	6,3	3,548E+25
30	Çınarcık Basin SE	40,718362	28,832943	40,694693	29,003135	40,706528	28,918039	SSF	100	80	5	14,5	10	145,0	5,4	0,4	6,2	2,5119E+25	0,8	6,3	3,548E+25
31	Marmara	40,730071	28,812419	40,74067	28,952277	40,735371	28,882348	RF	85	80	90	12	10	120,0	5,4	0,4	6,1	1,7783E+25	1,3	6,4	5,012E+25
32	Çınarcık	40,757586	28,995426	40,696959	29,133871	40,727273	29,064649	NF	120	80	270	13,5	12,5	168,8	6,7	0,5	6,2	2,5119E+25	2,6	6,7	1,413E+26

Table 1: Parametric information on the segments.

SCENARIO	SEGMENTS INCLUDED																														Fault Area (km ²)	L2010		WC1994						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		31	32	Mo (dyn/cm)	Mw	Davg (m)	Mo (dyn/cm)	Mw	Davg (m)	
Segment Area	247.5	225.0	330.0	165.0	547.5	115.0	95.0	110.0	335.0	68.8	112.5	75.0	43.8	100.0	87.5	450.0	110.0	225.0	90.0	80.0	145.0	40.0	115.0	35.0	397.5	360.0	540.0	75.0	80.0	145.0	120.0	168.8								
SN01	1.91	1.06	1.06	1.06																															1.81514E+26	6.8	0.58	4.01173E+26	7.0	1.28
SN02	1.40	1.40	1.40	1.40	4.249																														3.22767E+26	6.9	0.66	1.1955E+27	7.3	2.43
SN03	1.84	1.84	1.84	1.84	3.708	1.84	1.84	1.84																											3.65729E+26	7.0	0.61	1.26352E+27	7.3	2.12
SN04	1.55	1.55	1.55	1.55	3.534	1.55	1.55	1.55	3.534																										4.3623E+26	7.0	0.62	1.66163E+27	7.4	2.36
SN05	1.45	1.45	1.45	1.45	3.36	1.45	1.45	1.45	3.36	1.45	1.45																							4.5542E+26	7.0	0.60	1.71187E+27	7.4	2.24	
SN06					4.46																														1.41254E+26	6.7	0.79	7.94328E+26	7.2	4.46
SN07					3.823	1.75	1.75	1.75																											1.84215E+26	6.8	0.65	8.62349E+26	7.2	3.06
SN08					4.03	1.00	1.00	1.00	4.03																										2.5501E+26	6.9	0.65	1.26046E+27	7.3	3.23
SN09					3.643	1.63	1.63	1.63	3.643	1.63	1.63																								2.73908E+26	6.9	0.61	1.31069E+27	7.3	2.91
SN10					3.371	1.75	1.75	1.75	3.371																										2.88586E+26	6.9	0.59	1.32226E+27	7.3	2.70
SN11					2.988	1.12	1.12	1.12	2.988																										3.88586E+26	7.0	0.61	1.52178E+27	7.4	2.39
SN12																																			4.29613E+25	6.4	0.41	6.80205E+25	6.5	0.65
SN13																																			1.13758E+26	6.6	0.53	4.66128E+26	7.0	2.19
SN14																																			1.32655E+26	6.7	0.49	5.16365E+26	7.1	1.90
SN15																																			1.47332E+26	6.7	0.47	5.27928E+26	7.1	1.69
SN16																																			2.47332E+26	6.9	0.54	7.27494E+26	7.2	1.59
SN17																																			7.07946E+25	6.5	0.65	3.98107E+26	7.0	3.66
SN18																																			8.96934E+25	6.6	0.53	4.48345E+26	7.0	2.67
SN19																																			1.04E+26	6.6	0.50	4.60E+26	7.0	2.21
SN20																																			2.04371E+26	6.8	0.58	6.59434E+26	7.1	1.86
SN21																																			3.35766E+25	6.3	0.34	6.18005E+25	6.5	0.62
SN22																																			1.33577E+26	6.7	0.54	2.61327E+26	6.9	1.06
SN23																																			7.53972E+25	6.5	0.55	2.85126E+26	6.9	2.06
SN24																																			5.72152E+25	6.4	0.42	8.21231E+25	6.5	0.61
SN25																																			1E+26	6.6	0.77	1.99526E+26	6.8	1.54
SN26																																			1.70795E+26	6.8	0.69	3.4078E+26	7.0	1.38
SN27																																			3.12048E+26	6.9	0.74	6.22618E+26	7.1	1.48
SN28																																			4.29439E+25	6.4	0.44	9.60815E+25	6.6	0.99
SN29																																			3.56078E+25	6.3	0.40	1.10719E+26	6.6	1.24
SN30																																			2.51889E+25	6.2	0.46	1.41254E+26	6.7	2.58

Table 2: Displacements assigned to fault segments for 30 scenarios to be used in tsunami modelling

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