A Scientific Network
for Earthquake, Landslide & Flood Hazard Prevention

SciNetNatHazPrev – STAKEHOLDERS MEETING

NOVEMBER 12-13, 2015, ISTANBUL, TURKEY

VENUE: MAÇKA SOCIAL CENTER, ISTANBUL TECHNICAL UNIVERSITY FOUNDATION

SEISMIC HAZARD ASSESSMENT METHODOLOGIES for TURKEY

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The main objectives of this project is

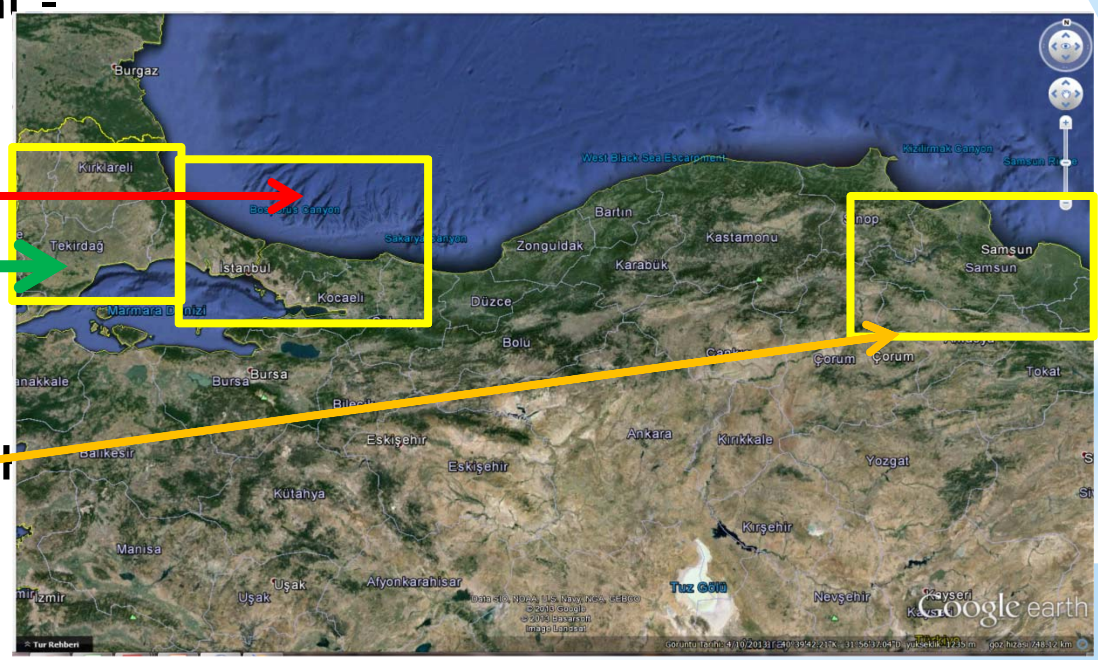
- to setup common terminology, methodologies and strategies for Earthquake, Landslide and Flood Hazards (ELFH) prevention.
- To built a WebGIS platform including digital data and information to the scientific community interested in Earthquake, Landslide and Flood Hazards (ELFH)
- To Implement finally selected (developed or adapted) methodologies to assess hazards on a regional scale and on local scale in selected locations.
- To provide training with open seminars and workshops

Regional Scale): Marmara Region (Time Dependent and Time Independent - PSHA)

- **ISTANBUL**
- **TEKİRDAĞ**

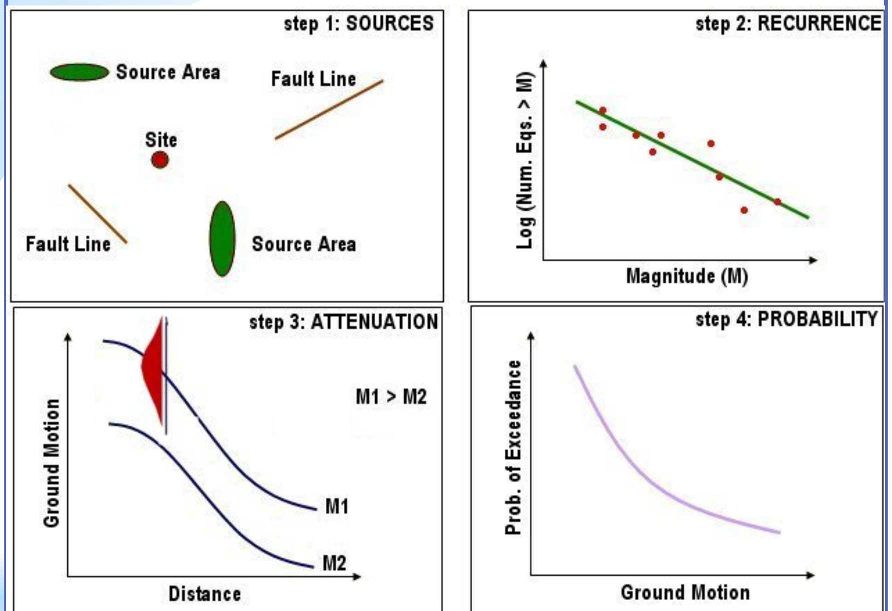
Local Scale:
(Time Independent -PSHA and DSI

- **SAMSUN**



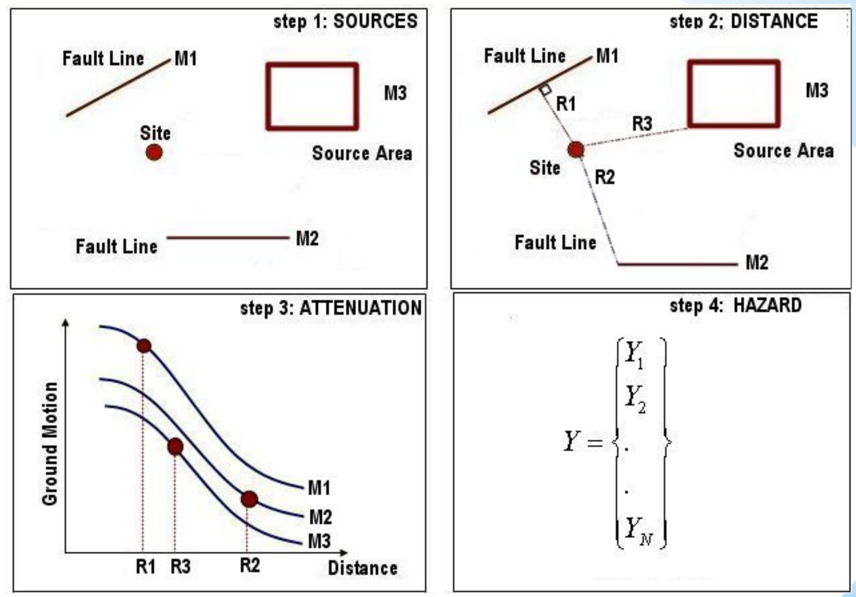
Seismic Hazard Analysis

- **Probabilistic SHA - PSHA**



Step of the analysis (1) Definiton of the seismic sources (2) earthquake recurrence characteristics for each source, (3) GMPEs with magnitude and distance, and (4) ground motions for specified probability of exceedance levels (calculated by summing probabilities ovel all the sources, magnitude and distances)

- **Deterministic SHA - DSHA**

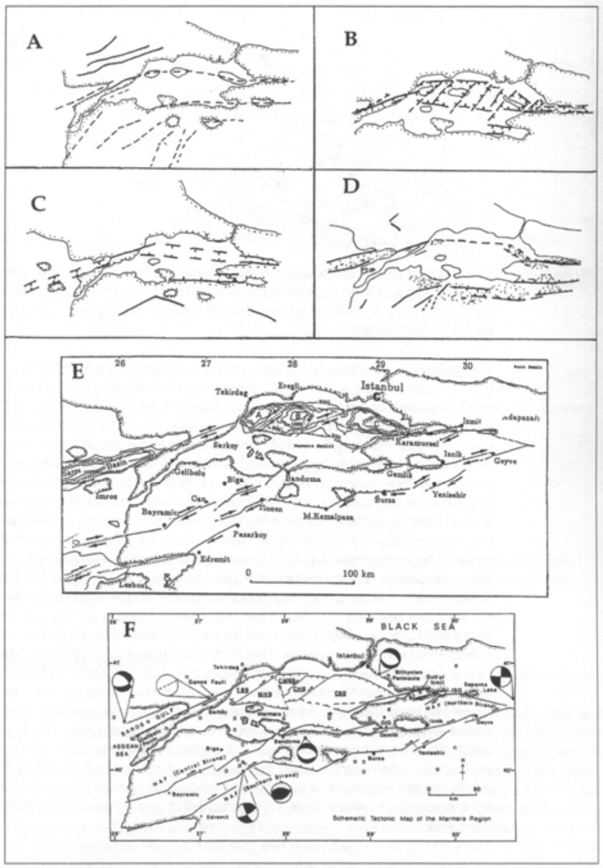


Step of the analysis (1) Definiton of the seismic sources (2) selection of a source to site distance parameter for each source zone, (3) Selection of the controlling earthquake (GMPEs with magnitude and distance), and (4) Definition of the hazard at site in terms of the ground motions produced at the site by the controlling earthquake.

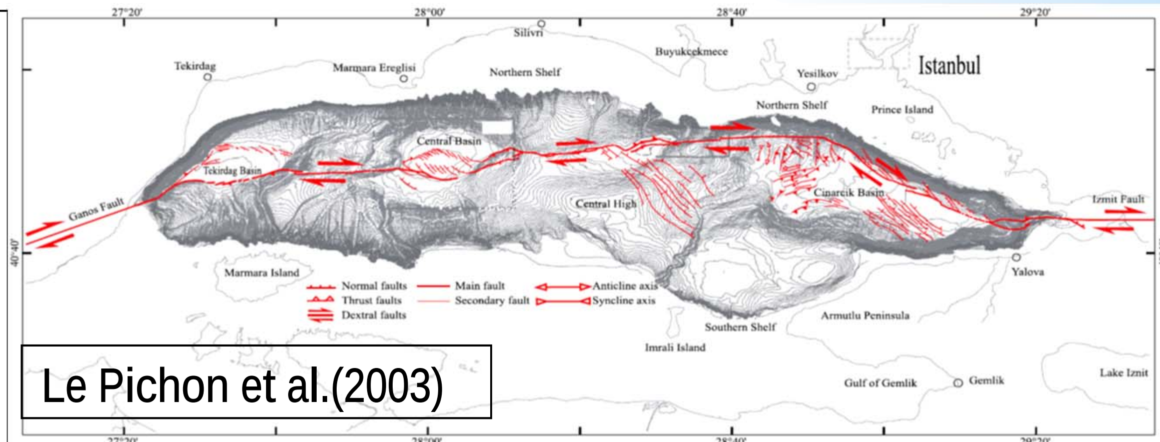
Seismic Hazard Assessment: *For the Source Model:* Tectonic Settings

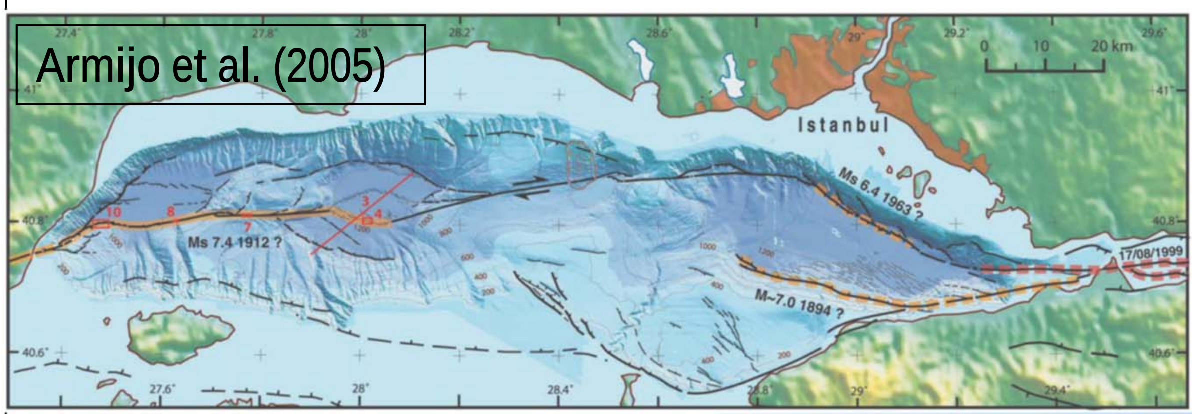
MARMARA REGION

The most prominent models are the “pull apart” model (A) proposed by Armijo et al. (2005) and the “single fault” model (B) proposed by Le Pichon et al. (2003).



Comparison of the structural models suggested for the Marmara region. (a) Pınar (1943), (b) Pfannenstiel (1944), (c) Crampin and Evans (1986), (d) Şengör (1987), (e) Barka and Kadınsky-Cade (1988), f) Wong et al. (1995), Ergün and Özel (1995).

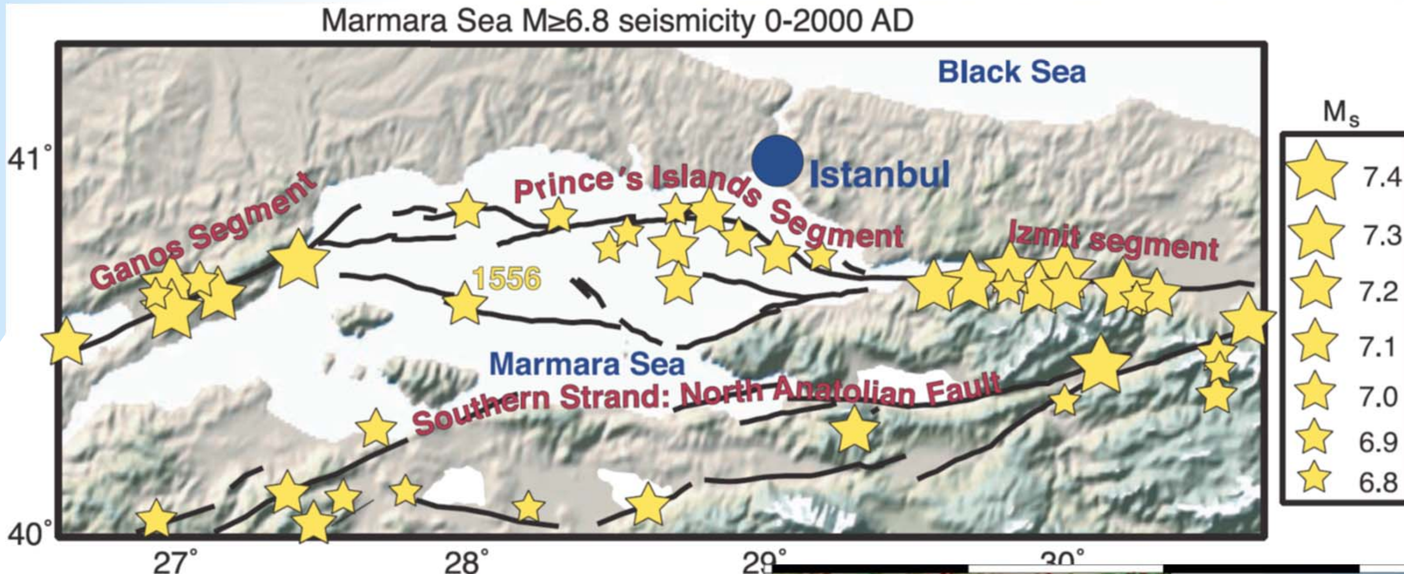


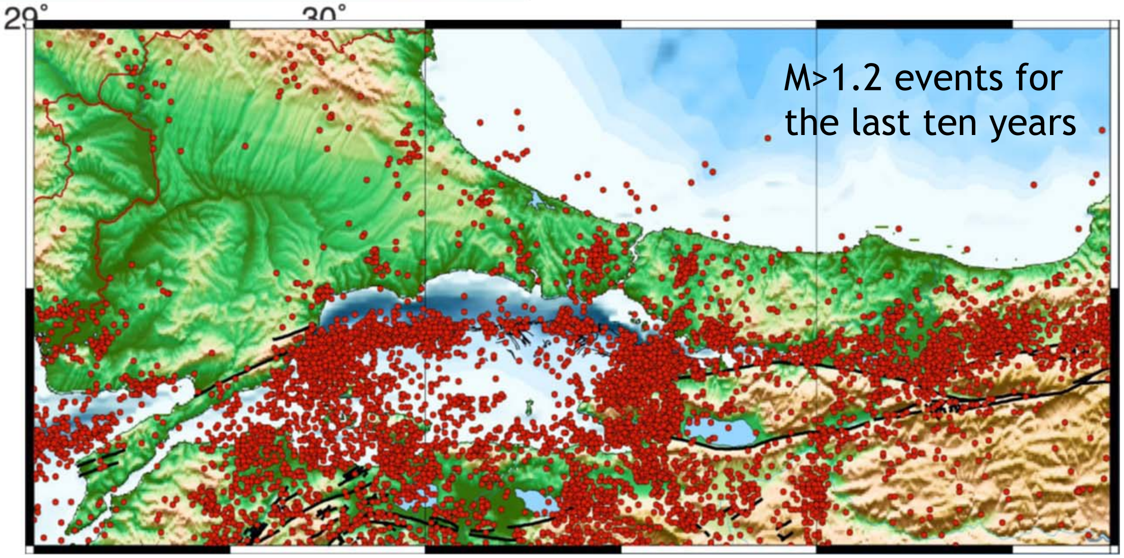


Seismic Hazard Assessment: *For the Source Model:*

Distribution of Seismicity

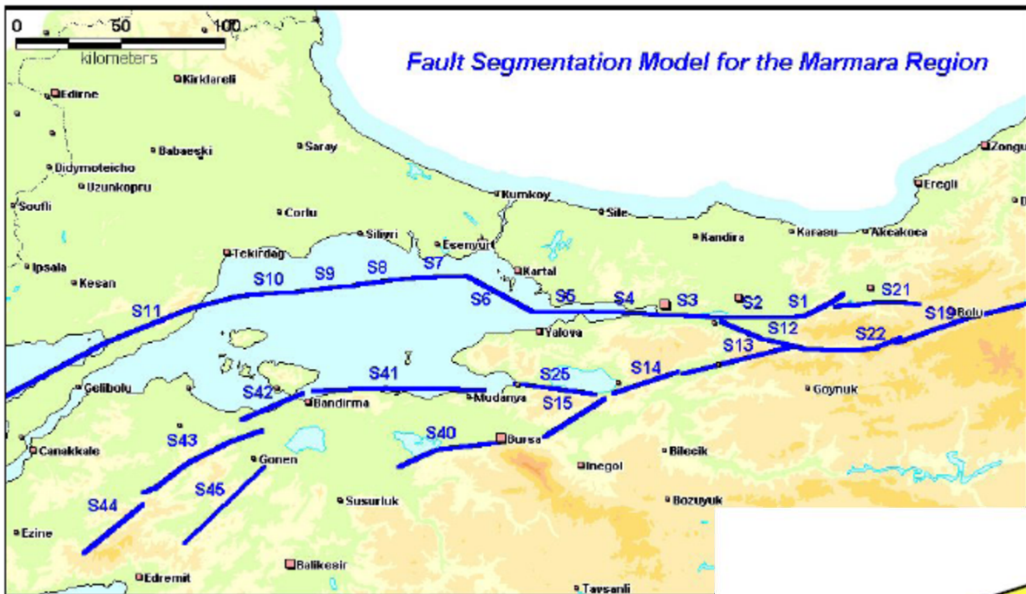
MARMARA REGION





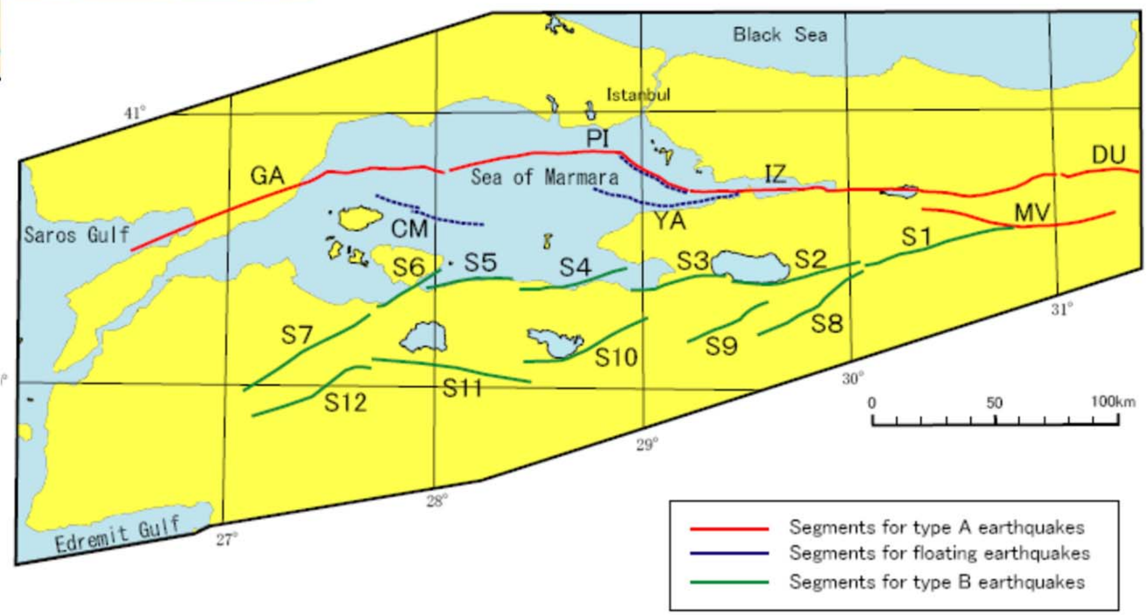
Seismic Hazard Assessment: *Two Source Model for Marmara Region:*

MARMARA REGION



Bogazici University

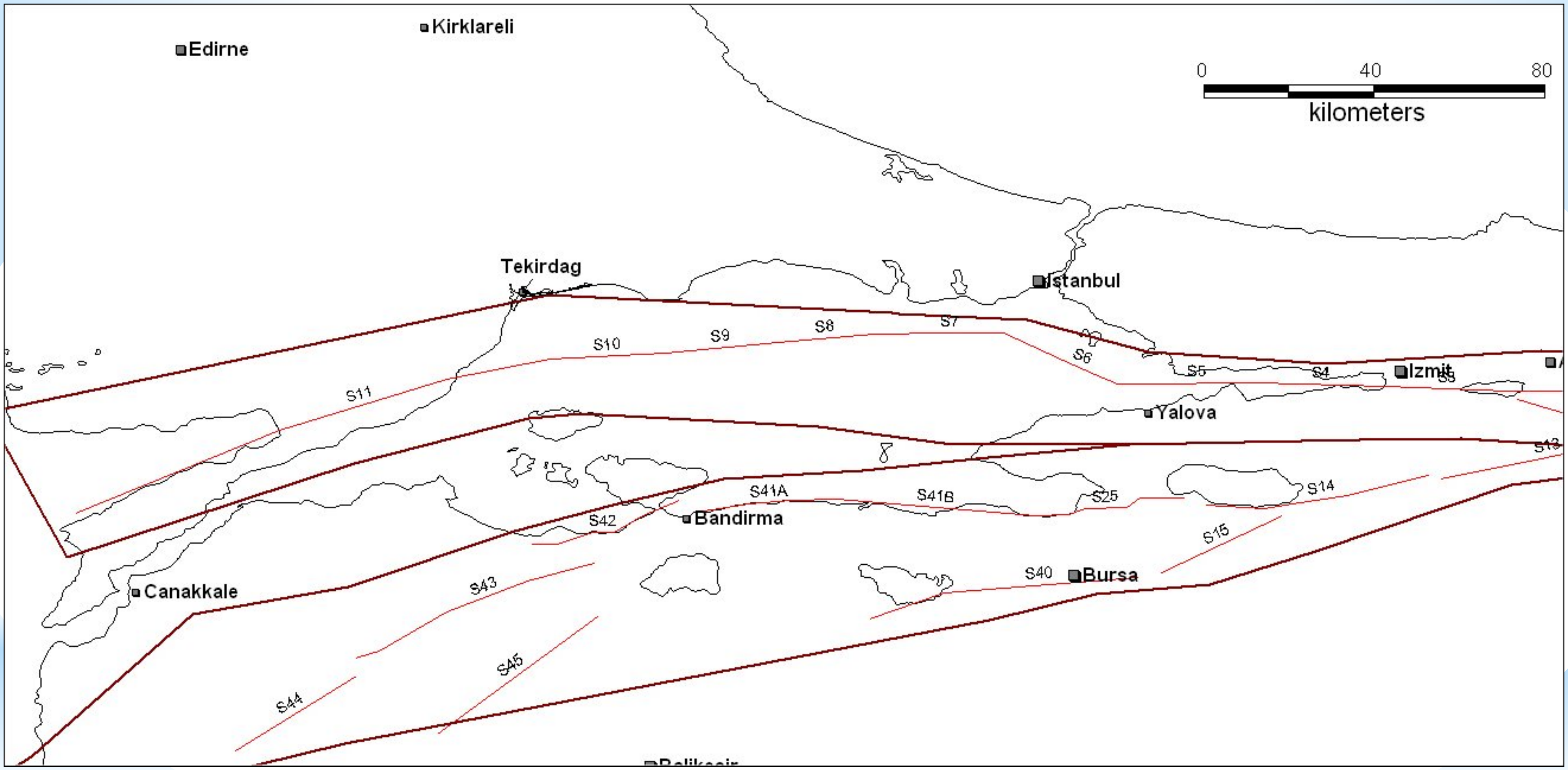
and Istanbul Metropolitan Municipality



FAULT SEGMENTATION MODELS

Seismic Hazard Assessment: *Two Source Model for Marmara Region:*

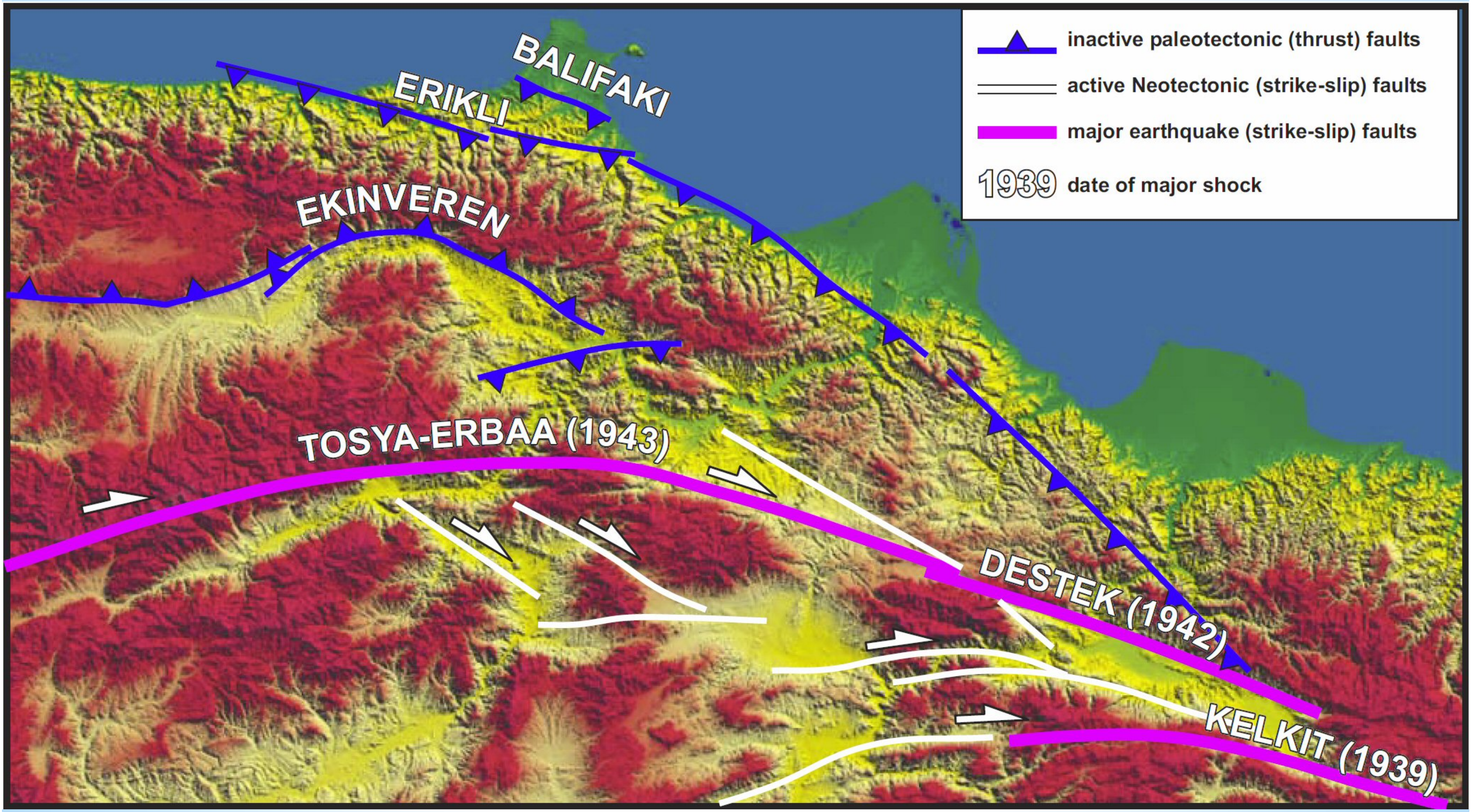
MARMARA REGION



Tectonic Settings

SAMSUN REGION

Kaymakçı, 2009



SEISMICITY

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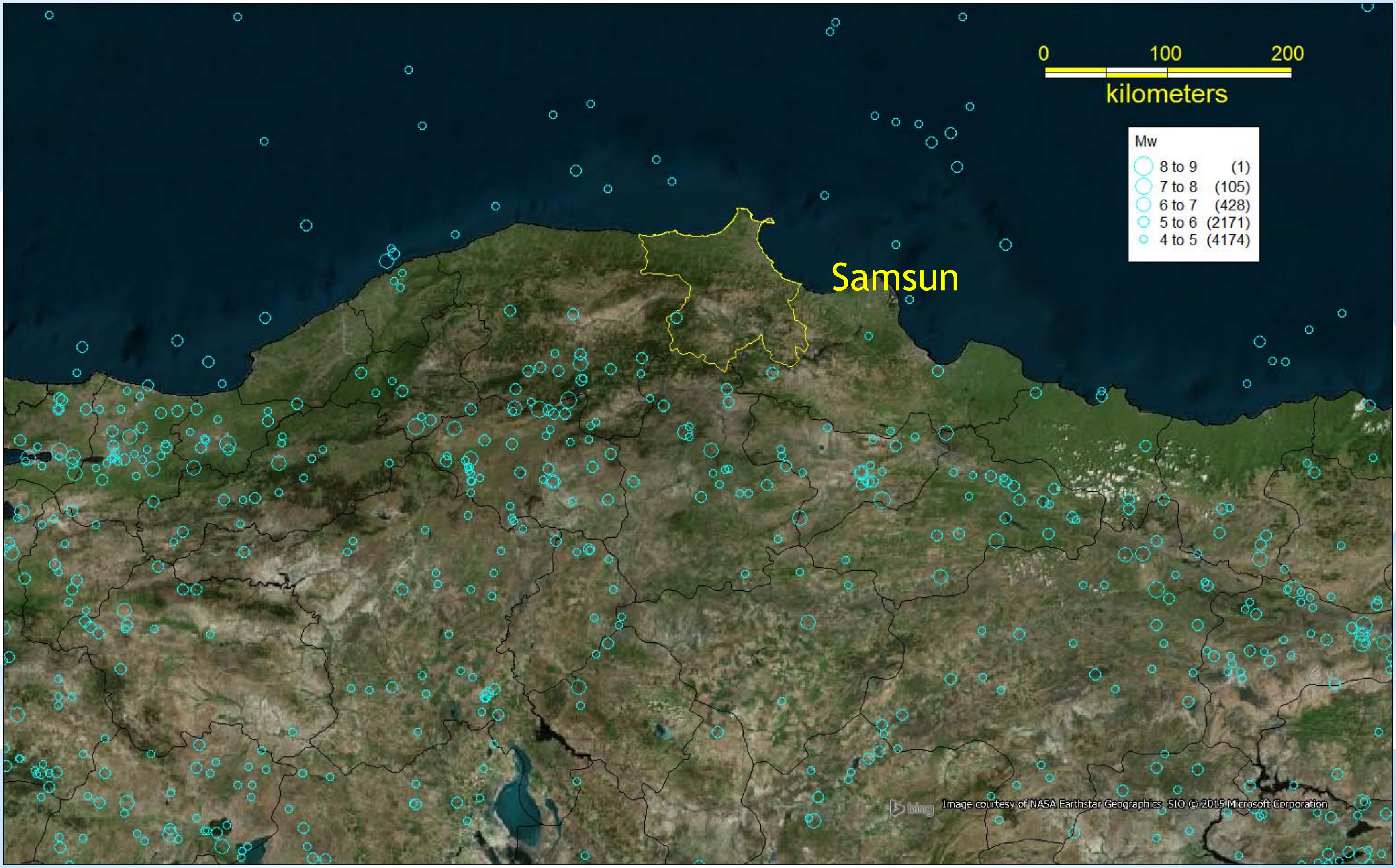

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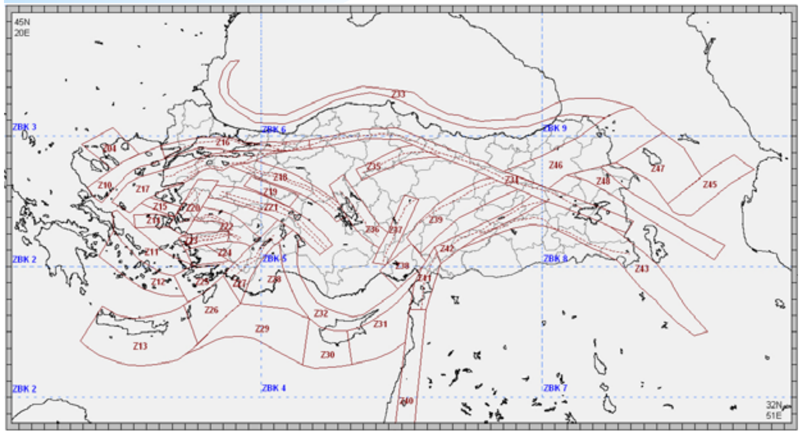
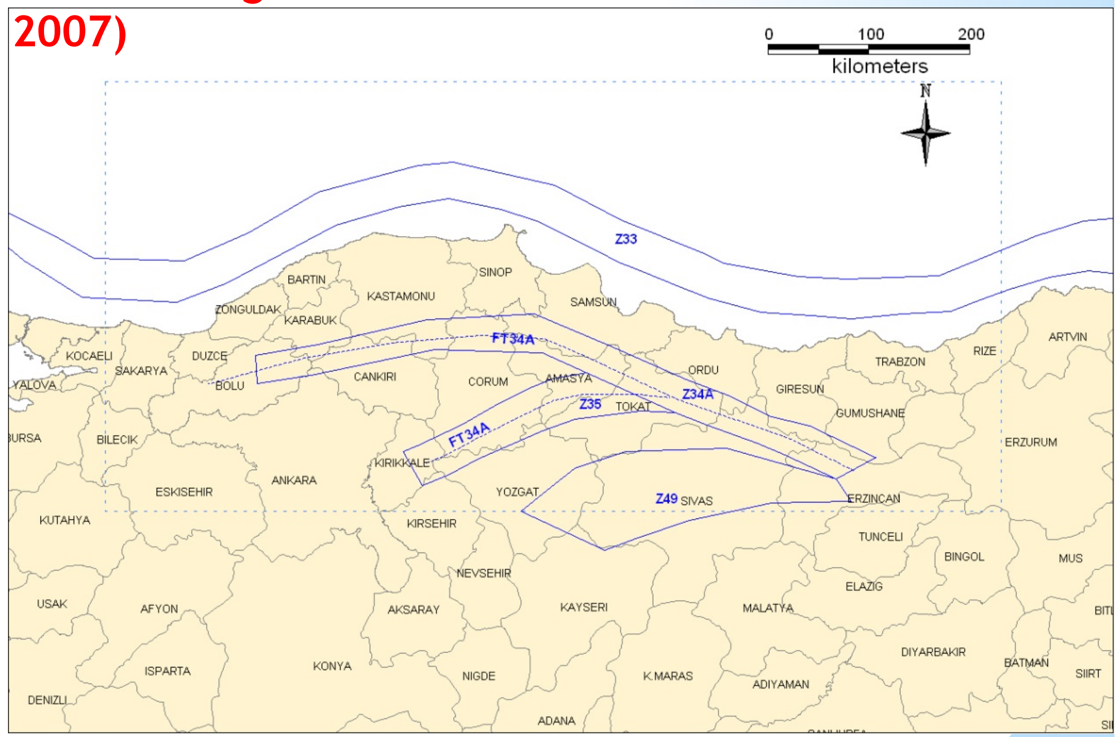
Seismic Hazard Assessment: *For the Source Model:*

The seismic source zonation model of Turkey developed within the context of a project conducted for the Ministry of Transportation Turkey, aiming the preparation of an earthquake resistant design code for the construction of railways, seaport and airport. (DLH, 2007)





- The earthquakes with magnitude > 6.5 are assumed to take place on the linear zones (Purple line), whereas the smaller magnitude events associated with the same fault are allowed to take place in the surrounding larger areal zone(Green Line).
- In addition to linear and areal source zones, background seismicity zones are defined to model the floating earthquakes that are located outside these distinctly defined source zones and to delineate zones where no significant earthquake has taken place.

* ESTIMATION OF THE SOURCE SEISMICITY PARAMETERS AND PROBABILISTIC MODEL

The earthquake recurrence model for the fault segments

- **Poisson Model**
  - ✓ characteristic earthquake recurrence is assumed,
  - ✓ probability of occurrence of the characteristic event does not change in time
  - ✓ The annual rate is calculated as:

    R=1/ mean recurrence interval

- **Time Dependent (Renewal model)**
  - ✓ the probability of occurrence of the characteristic event increase s as a function of the time elapsed since the last characteristic event,
  - ✓ A lognormal distribution with a coefficient of variation of 0.5 is assumed to represent the earthquake probability density distribution.
  - ✓ The annual rate is calculated as:

    Reff=-ln(1-Pcond) / T

Calculation of the probability For 200 yrs return Period and **exposure periods of 50 yrs**

P=1-exp(-(1/yinelenme süresü)*T)

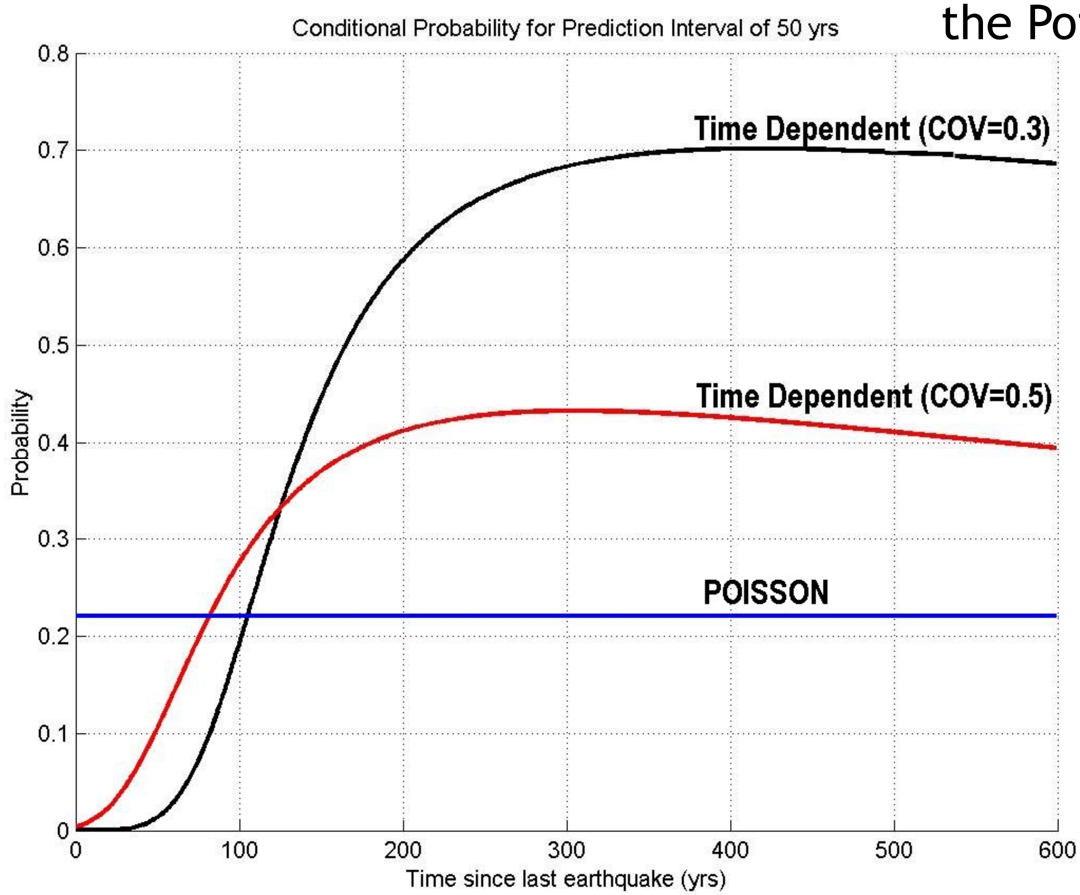
Yinelenme süresi = 200

T=50 yıl

P=1-exp((-1/200)*50))

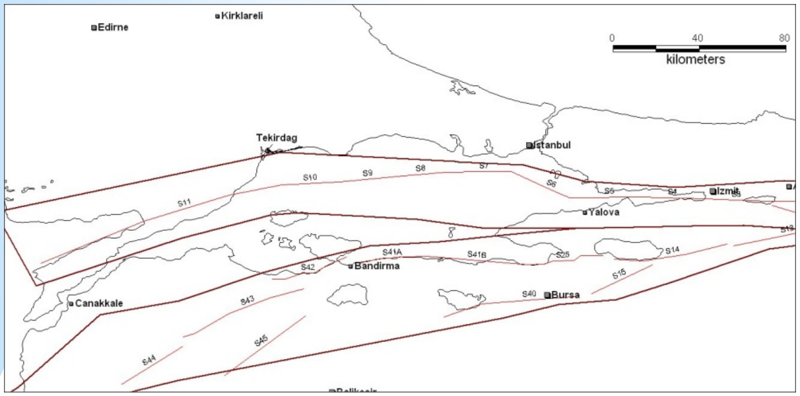
P=0.22

The figure shows that the probability remains constant for the Poisson model and that as the covariance becomes larger, the conditional probability approaches the Poisson probability



* ESTIMATION OF THE SOURCE SEISMICITY PARAMETERS AND PROBABILISTIC MODEL for (Time-dependent method - the Marmara region)

MARMARA REGION



						Time dependent (Renewal)		Poissonian
Segment	Last Char. Eq.	"cov"	Ortalama Yineleme süresi	Karakteristik Mag.	Son depremden bu yana geçen süre.	50year Prob.	Annual Rate	Annual Rate
1	1999	0.5	140	7.2	15	0.08260	0.00172	0.0071
2	1999	0.5	140	7.2	15	0.08260	0.00172	0.0071
3	1999	0.5	140	7.2	15	0.08260	0.00172	0.0071
4	1999	0.5	140	7.2	15	0.08260	0.00172	0.0071
5	1894	0.5	175	7.2	120	0.39620	0.01009	0.0057
6	1754	0.5	210	7.2	260	0.41200	0.01062	0.0048
7	1766	0.5	250	7.2	248	0.34280	0.00840	0.0040
8	1766	0.5	250	7.2	248	0.34280	0.00840	0.0040
9	1556	0.5	200	7.2	458	0.41730	0.01080	0.0050
10	-	0.5	200	7.2	1012	0.33250	0.00808	0.0050
11	1912	0.5	150	7.5	102	0.44960	0.01194	0.0067
12	1967	0.5	250	7.2	47	0.03810	0.00078	0.0040
13	-	0.5	600	7.2	1012	0.17200	0.00377	0.0017
14	-	0.5	600	7.2	1012	0.17200	0.00377	0.0017
15	-	0.5	1000	7.2	1012	0.09790	0.00206	0.0010
19	1944	0.5	250	7.5	70	0.08750	0.00183	0.0040
21	1999	0.5	250	7.2	15	0.00450	0.00009	0.0040
22	1957	0.5	250	7.2	57	0.05750	0.00118	0.0040
25	-	0.5	1000	7.2	1012	0.09790	0.00206	0.0010
40	1855	0.5	1000	7.2	159	0.00092	0.00002	0.0010
41	-	0.5	1000	7.2	1012	0.09790	0.00206	0.0010
42	-	0.5	1000	7.2	1012	0.09790	0.00206	0.0010
43	1737	0.5	1000	7.2	277	0.01010	0.00020	0.0010
44	-	0.5	1000	7.2	1012	0.09790	0.00206	0.0010
45	1953	0.5	1000	7.2	61	-	-	0.0010
				Mmin - Mmax	**alpha**	**Beta**		
BCK Z16	-	-	-	5.0 - 6.9	1.2078	1.767	-	
Z17	-	-	-	5.0-6.6	1.5136	2.0954	-	

* ESTIMATION OF THE SOURCE SEISMICITY PARAMETERS AND PROBABILISTIC MODEL for time-independent model (Turkey)

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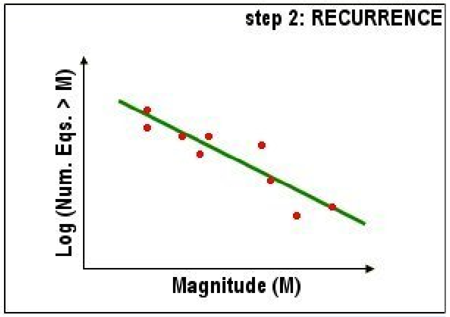
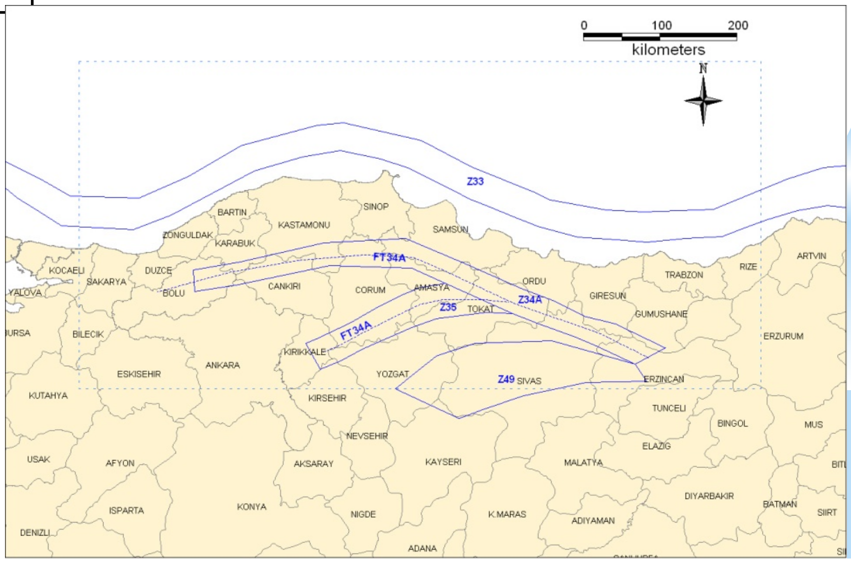
N is the number of the earthquakes above the magnitude M in a given region and within a given period
"a " and "b" are regression constants.

$$\log N = a + b\ M$$



Source Zone No	Associated Fault	a	b	M_{min} - M_{max}
Z33	Black Sea Fault	3.8	0.9	5.0 - 7.3
Z34 Outside Zone	North Anatolian Fault Zone (NAF)	5	0.8	5.0 - 6.7
Z34 Inside Zone				6.8 - 7.9
Z35 Outside Zone	Alaca Ezine Pazari Fault	3.2	0.8	5.0 - 6.7
Z35 Inside Zone				6.8 - 7.9
Z49	Deliler Fault Zone	4.4	1	5.0 - 7.3
ZBK1	Background	5.13	1	5.0-6.5



GROUND MOTION PREDICTION EQUATIONS

* The GMPEs used in the hazard analysis are listed:

- Akkar and Bommer (2009, rev:2010)
- Boore and Atkinson (2008)
- Chiou and Youngs (2008)
- Campbell and Bozorgnia (2008)
- Abrahamson and Silva (2008)

Ground Motion Parameters:

- PGA
- Sa(T=0.2sn)
- Sa(T=1.0sn)

Return Periods:

72, 475, 2475 years

Model	Area	Magnitude Range	Distance Range (km)	Period Range (s)	Site	Mechanism	Component
Abrahamson and Silva (2008)	California, Taiwan and other regions	Mw=5.0-8.0	Rrup = 0 – 200	0.01 – 10.0, PGA, PGV	Function of Vs30	N, R/T, S	GMRot150
Boore and Atkinson (2008)	California, Taiwan and other regions	Mw=4.27 – 7.9	Rjb = 0 – 280	0.01 – 10.0, PGA, PGV	Function of Vs30	N, R, S, U	GMRot150
Chiou and Youns (2008)	California, Taiwan and other regions	Mw=4.27 – 7.9	Rrup = 0.2 – 70	0.01 – 10.0, PGA, PGV	Function of Vs30	N, R, S	GMRot150
Campbell and Bozorgnia (2008)	California, Taiwan and other regions	Mw=4.27 – 7.9	Rrup = 0.07 – 199.27	0.01 – 10.0, PGA, PGV	Function of Vs30	N, R, S	GMRot150
Akkar and Bommer (2010)	European and Middle East	Mw=5.0-7.6	Rrup = 0 – 99	0.05-3.0, PGA,PGV	3 classes	N,R/T,S	GMEAN

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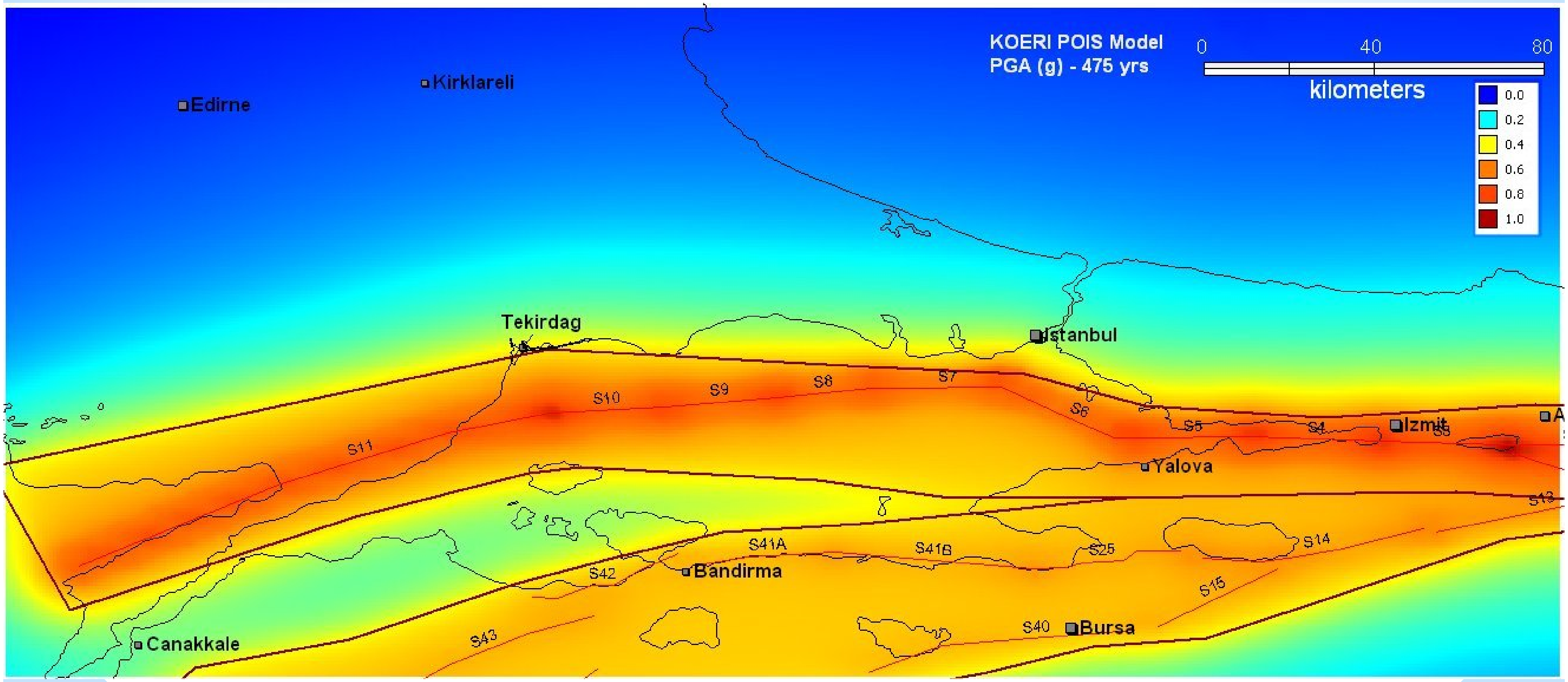
MARMARA REGION

Time Independent Model
NEHRP B/C Based PGA Distribution for %10 Probability of Exceedence in 50 years (475 years return period)



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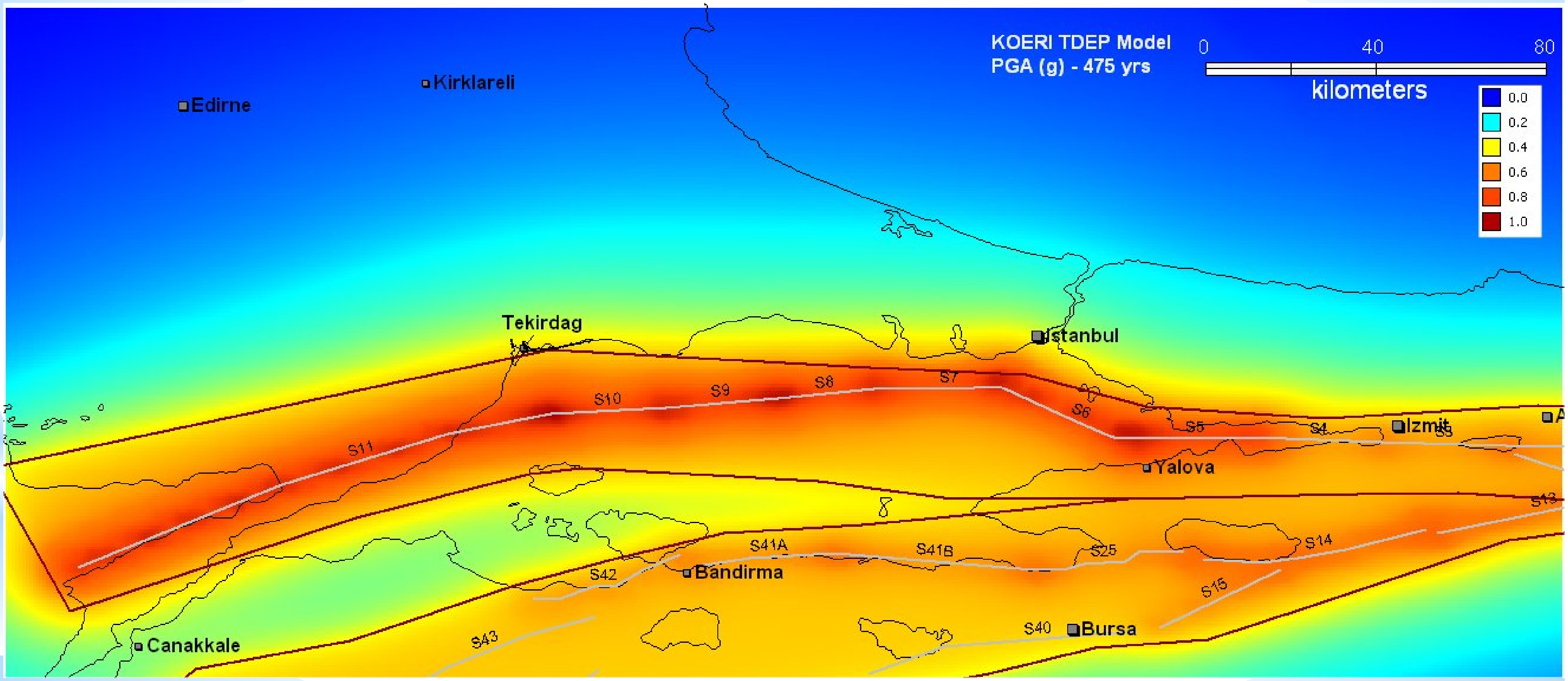

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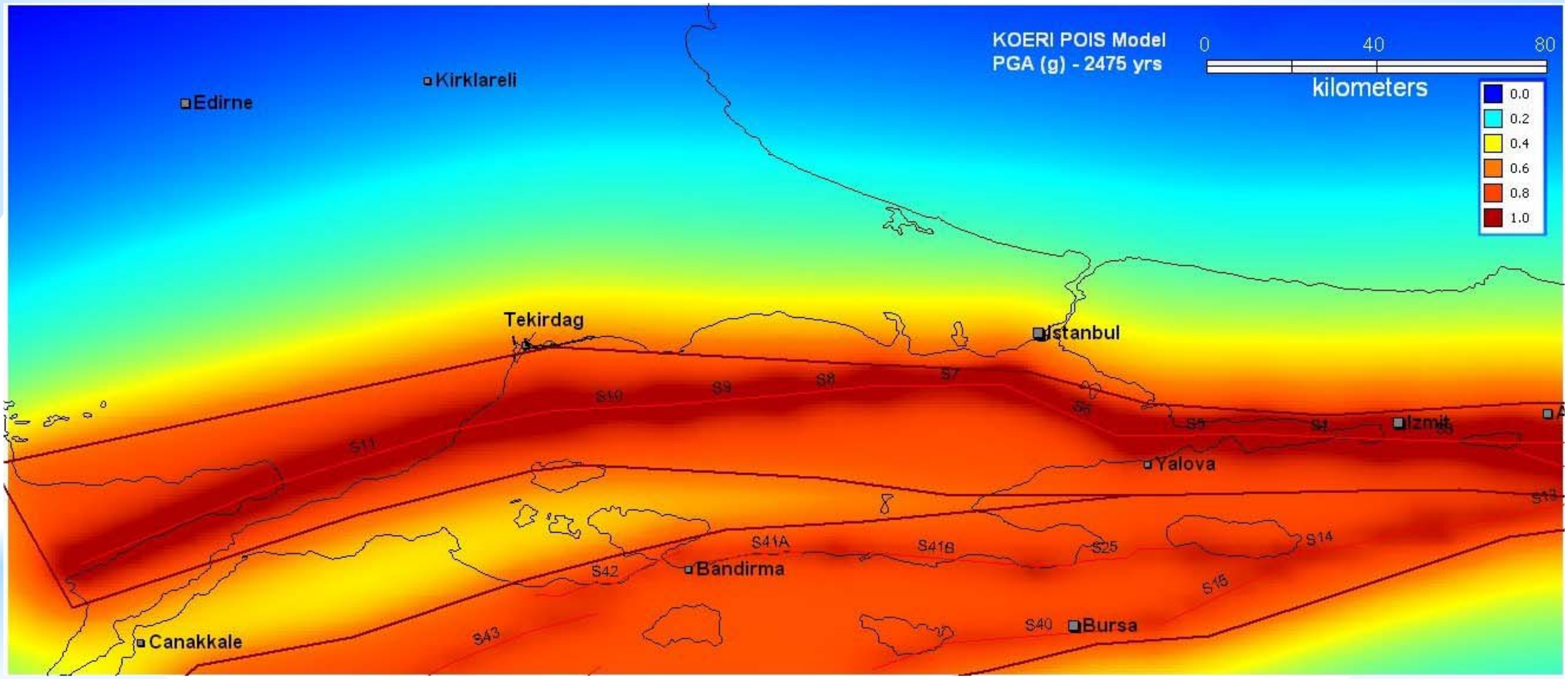

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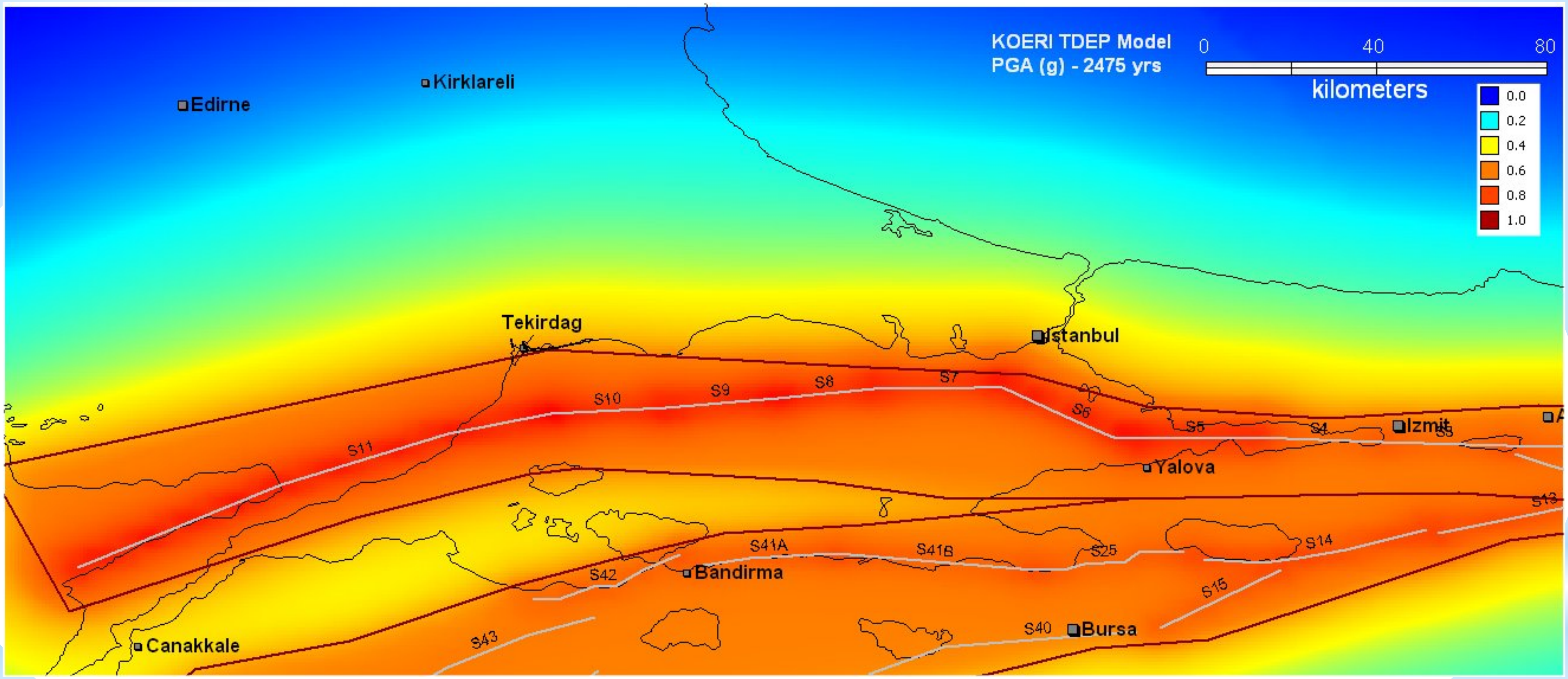

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Black Sea CROSS BORDER COOPERATION

MARMARA REGION

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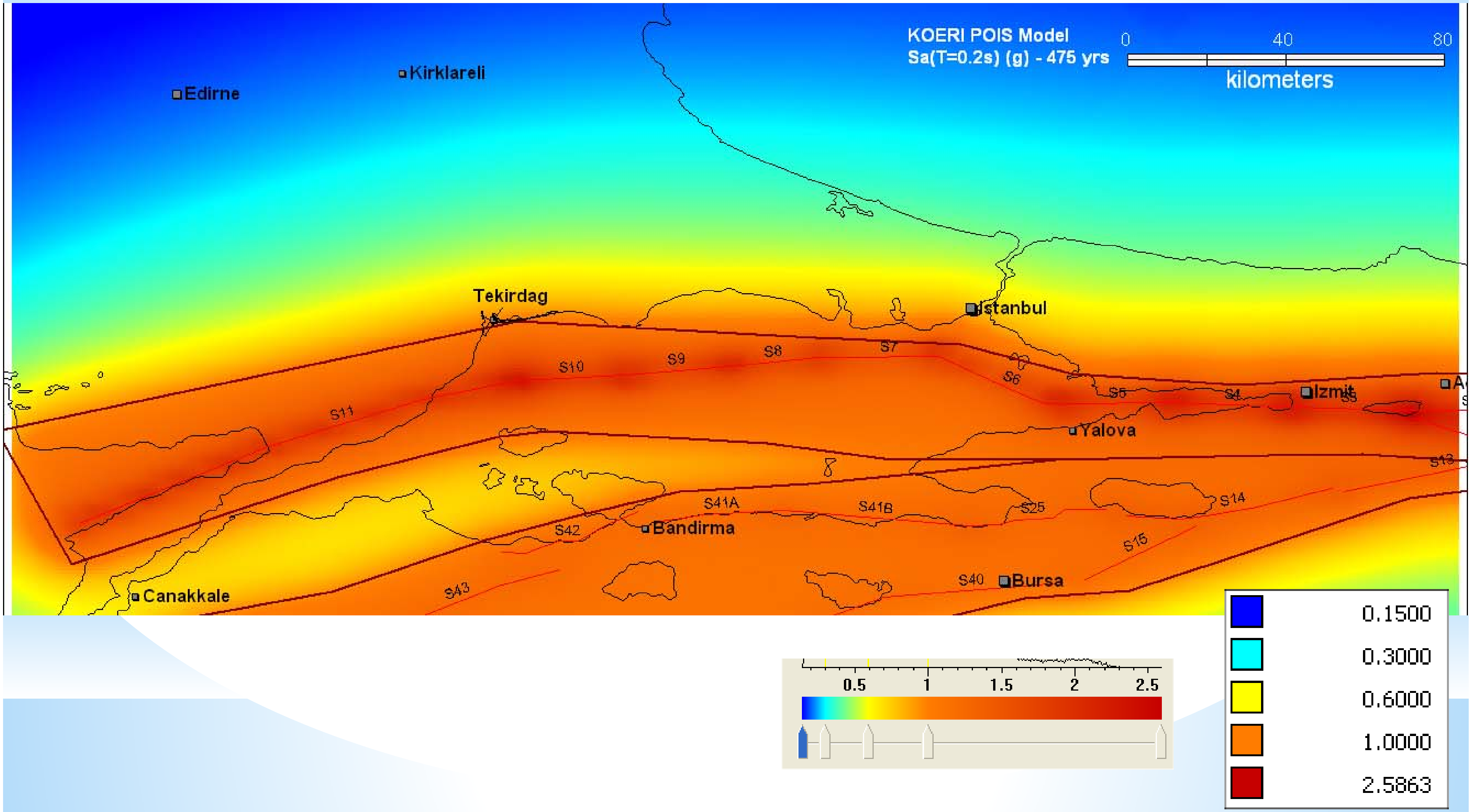

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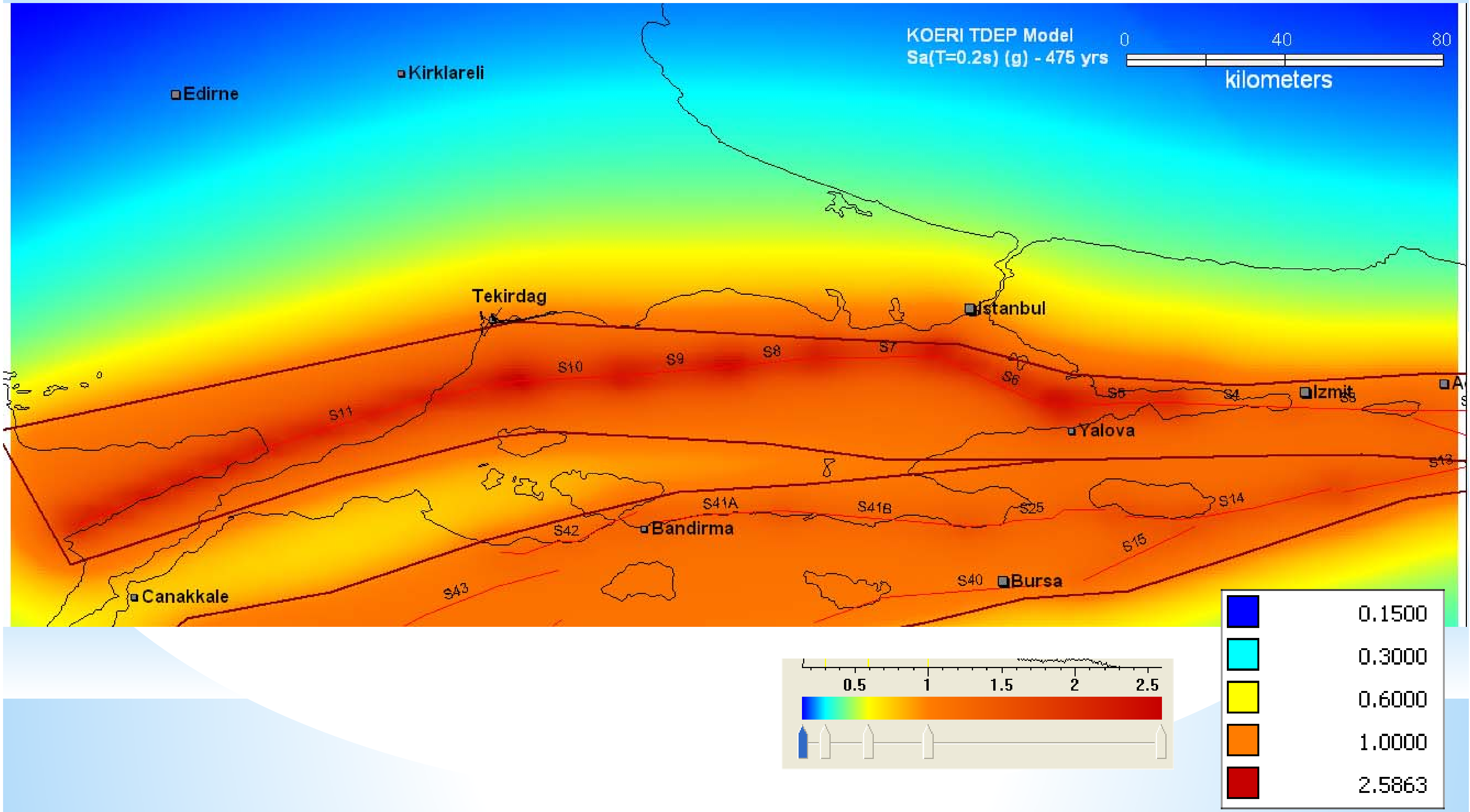

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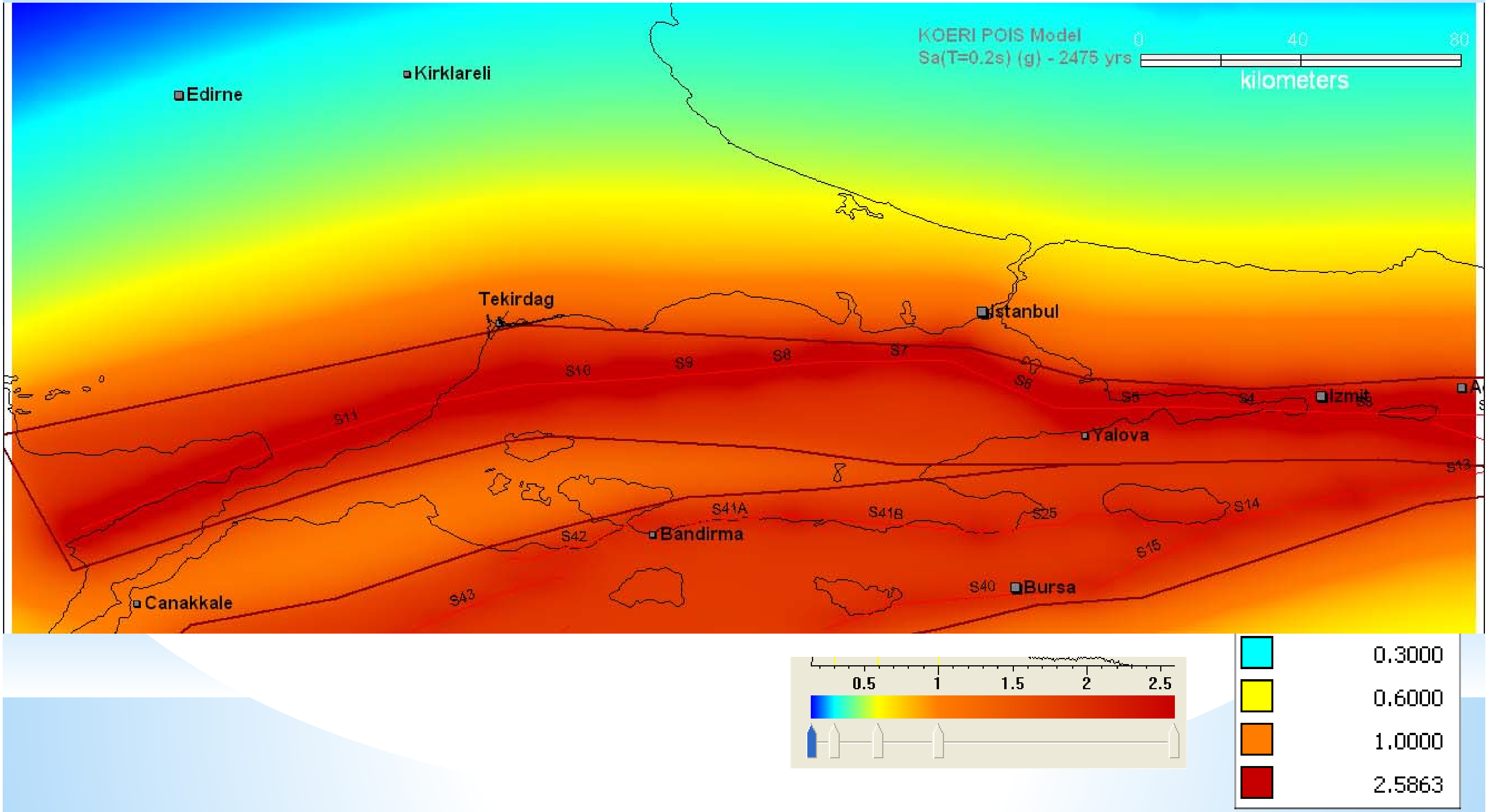

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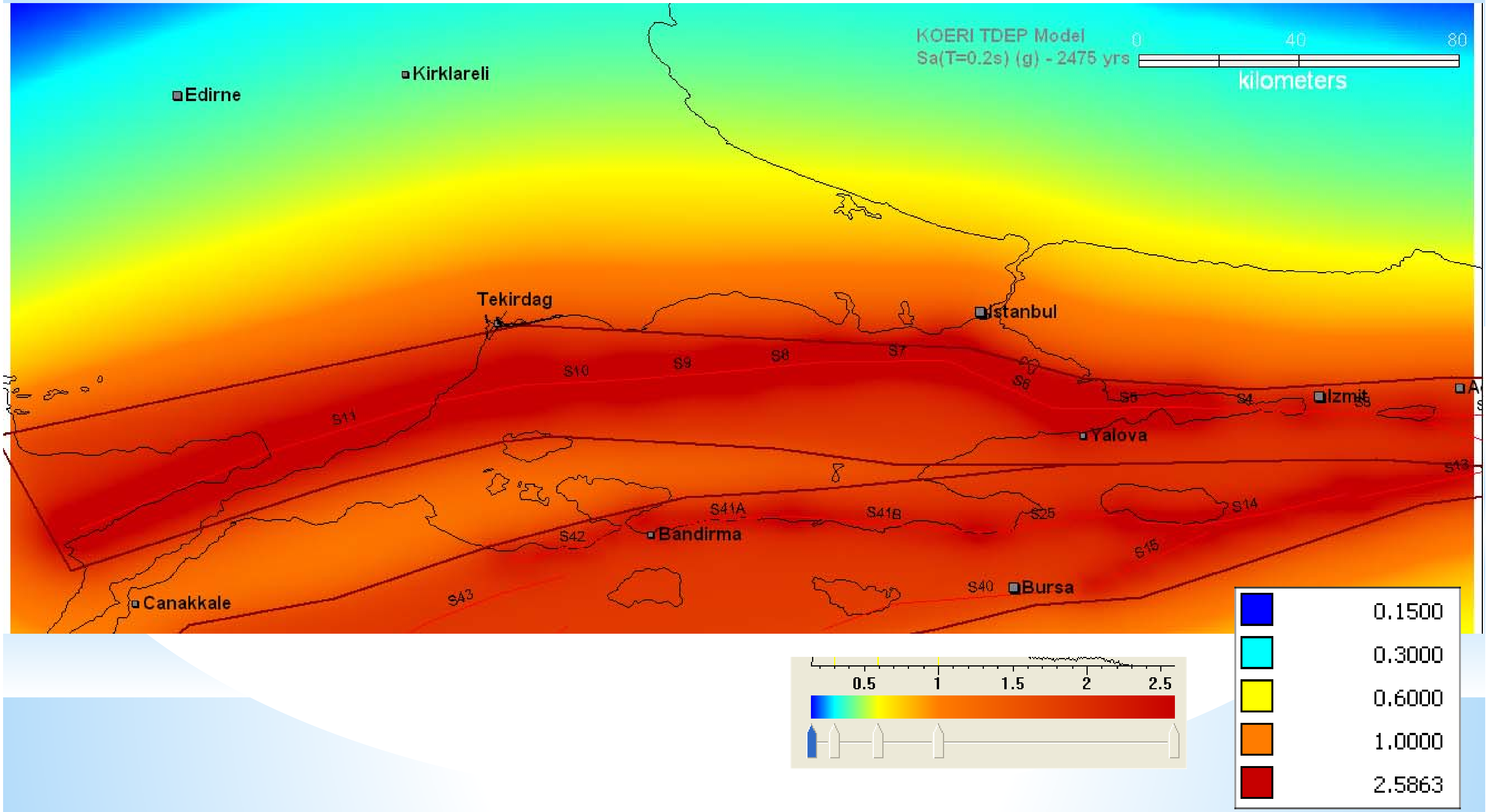

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Time Independent Model

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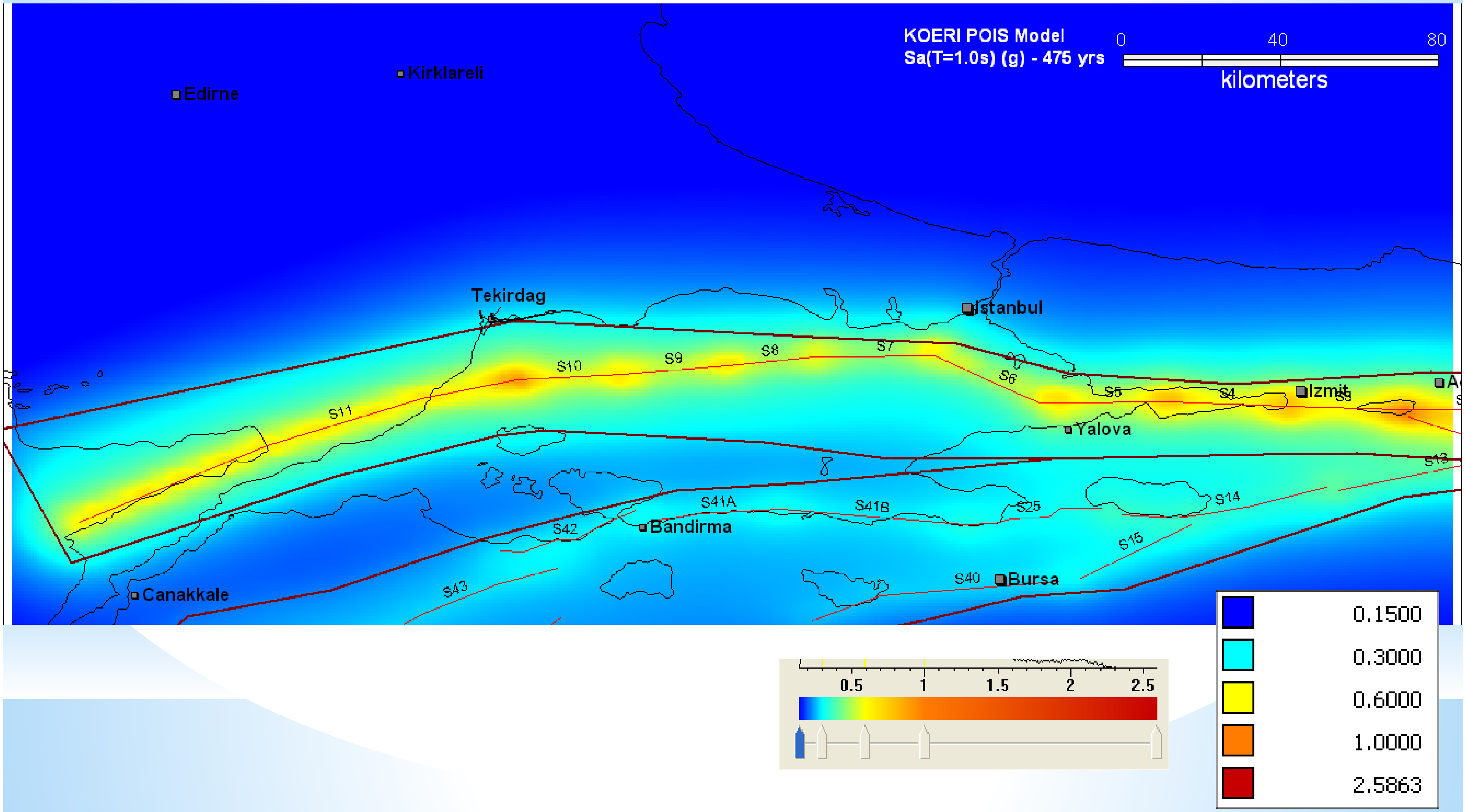
NEHRP B/C Based Sa(T=1.0s) Distribution for %10 Probability of Exceedence in 50 years (475 years return period)



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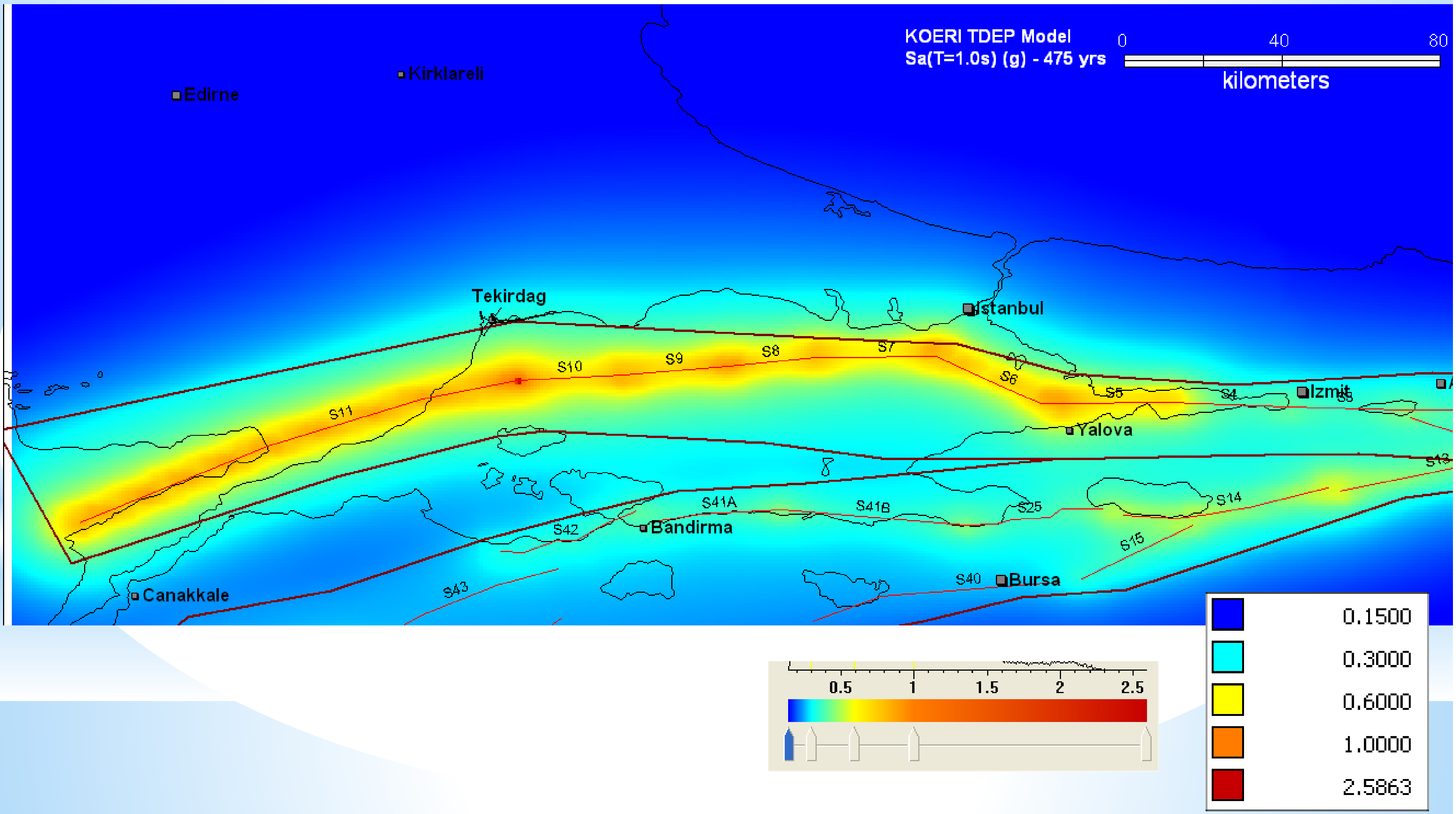

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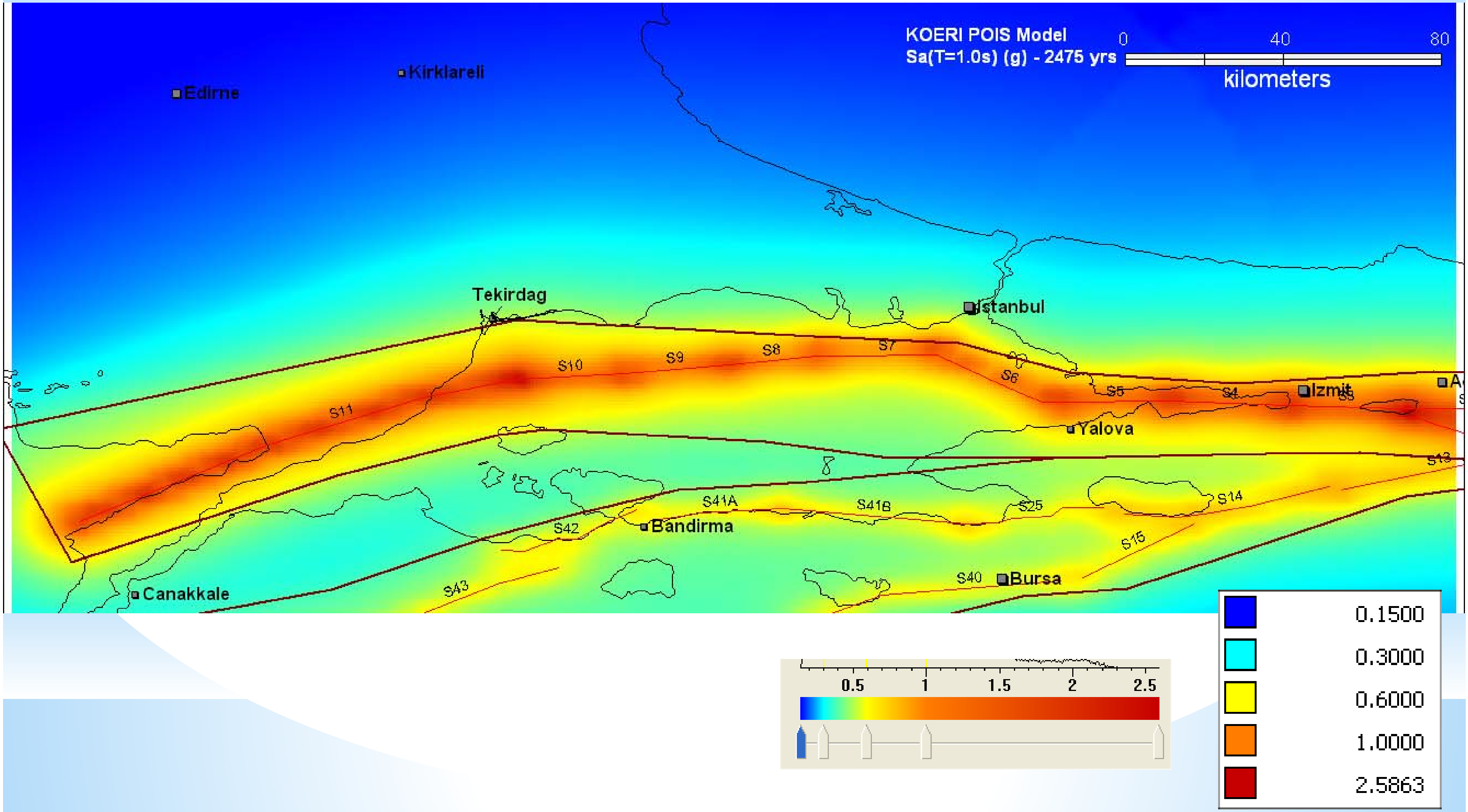

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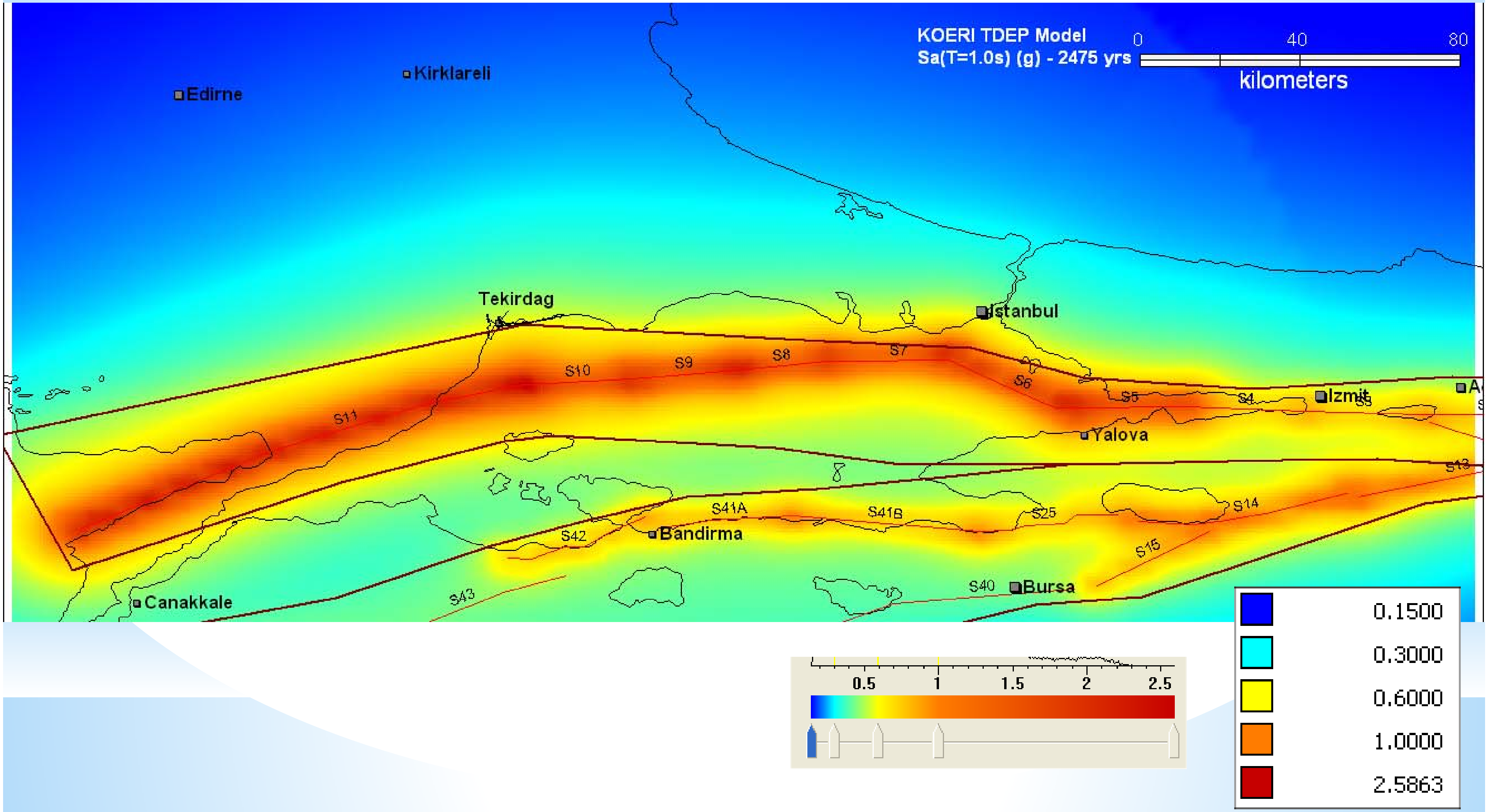

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Black Sea CROSS BORDER COOPERATION

Time Independent Model
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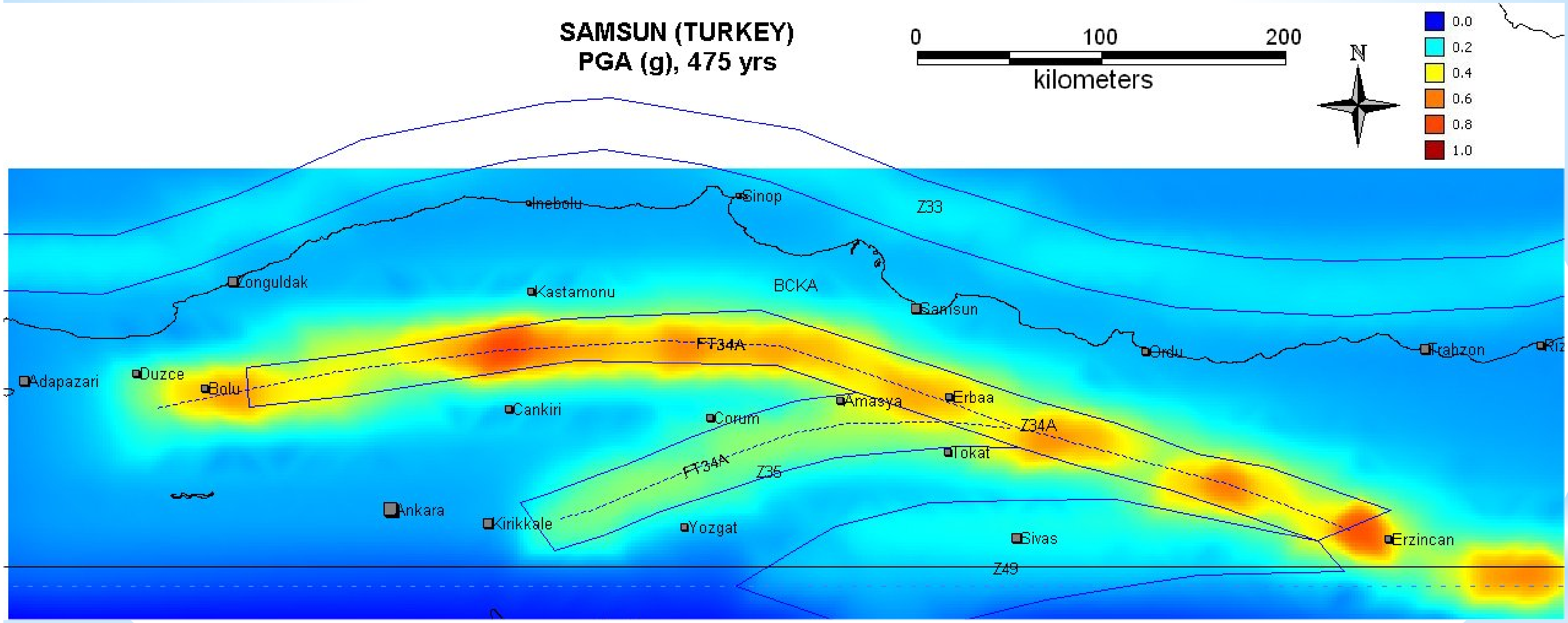

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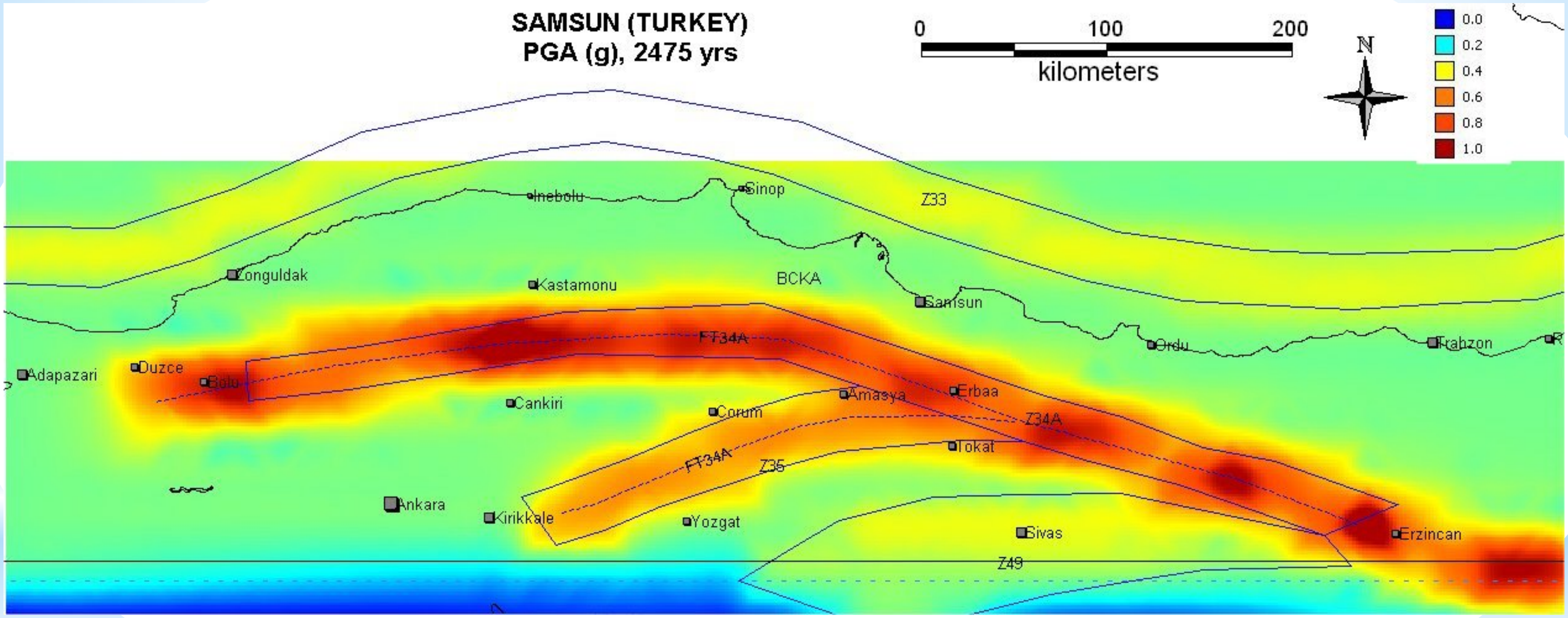

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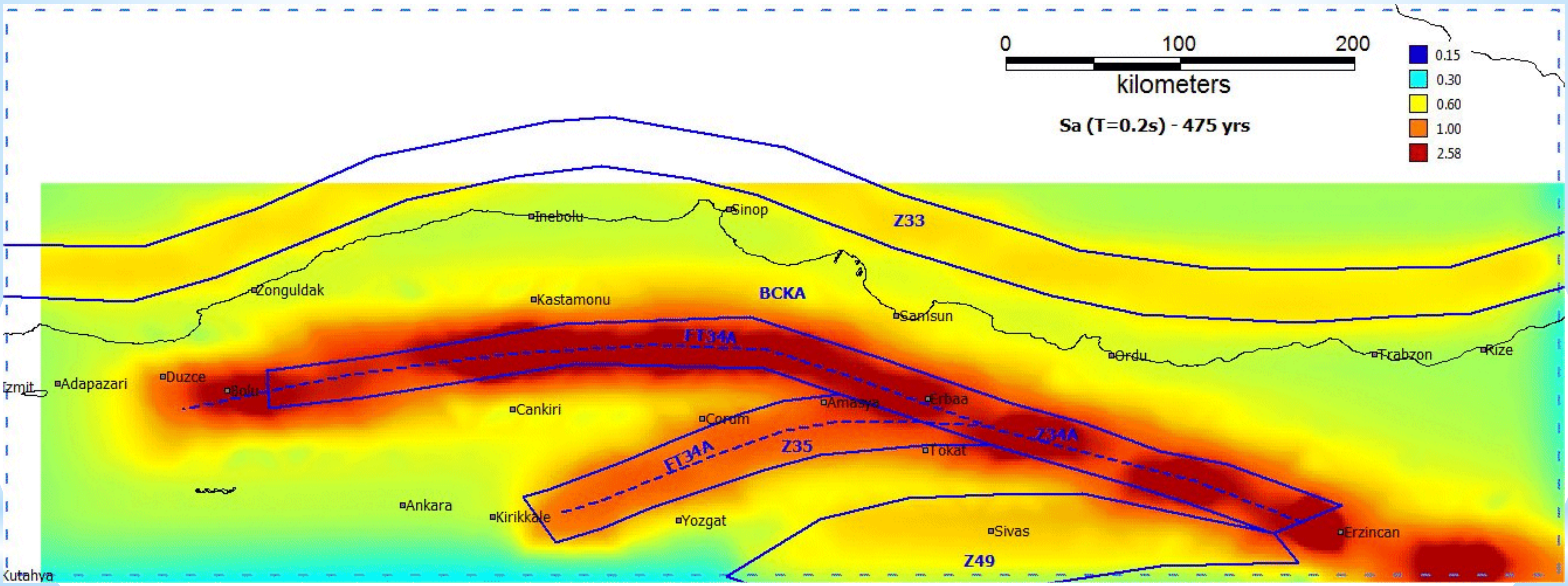

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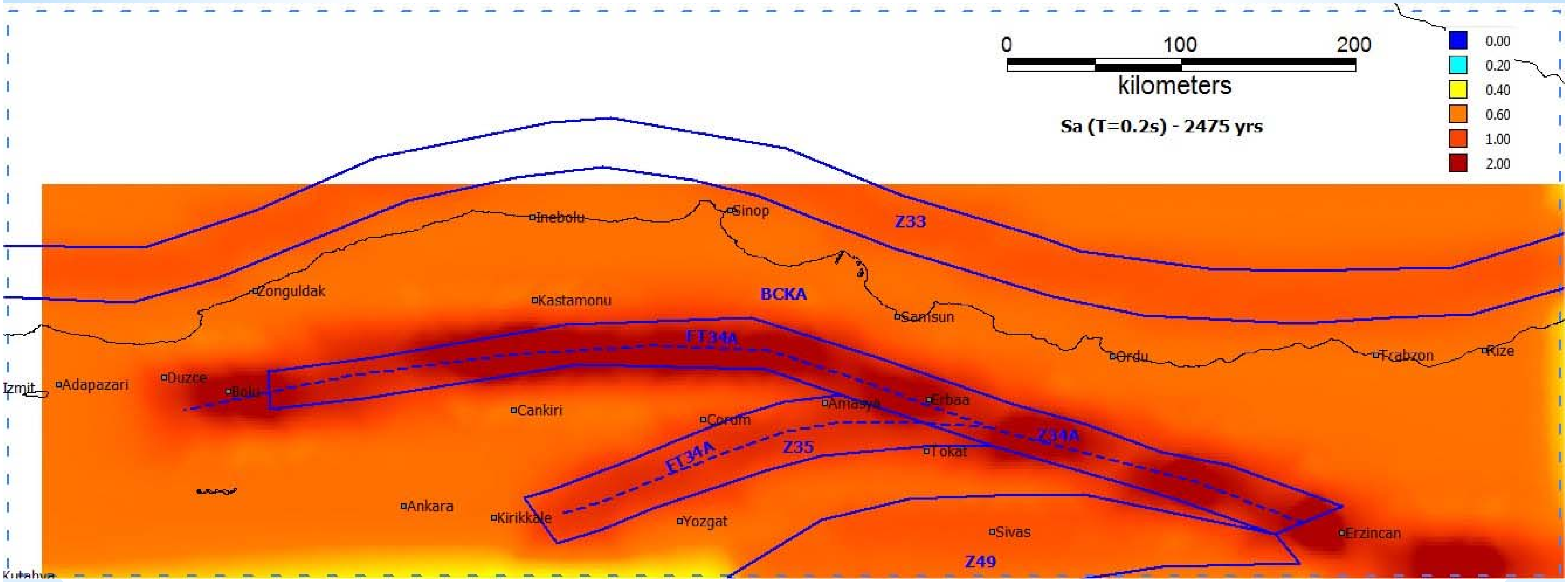

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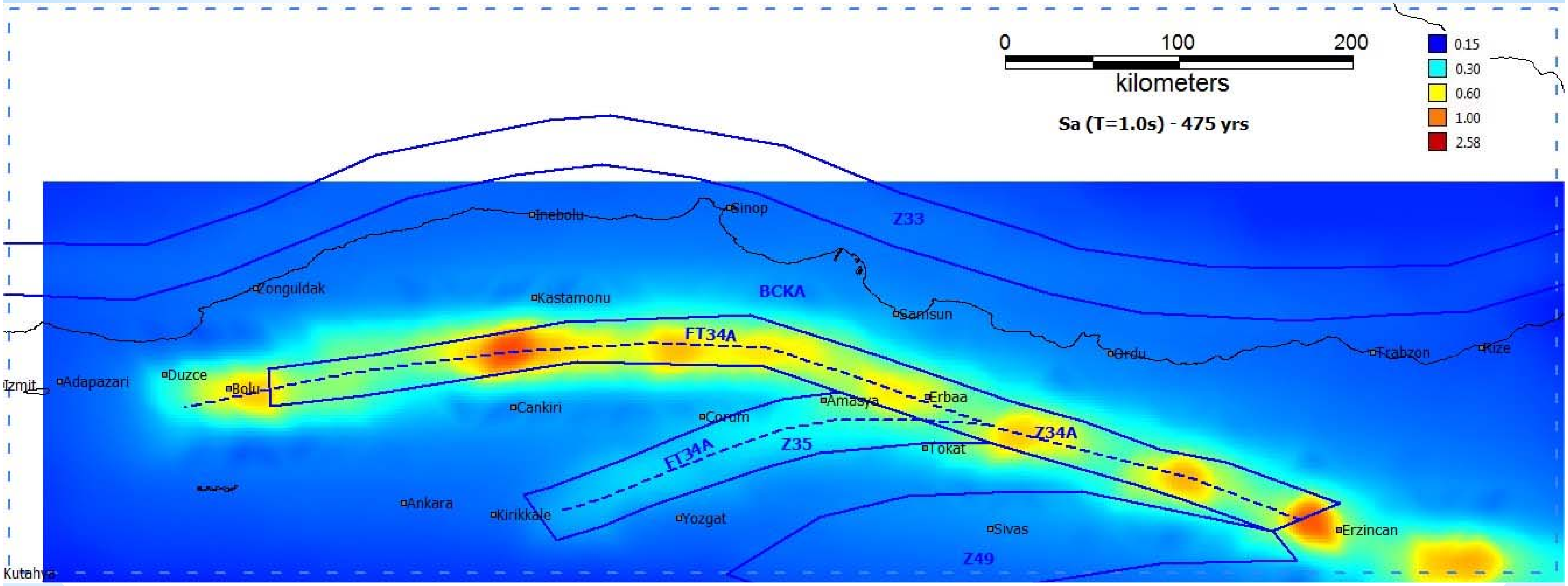

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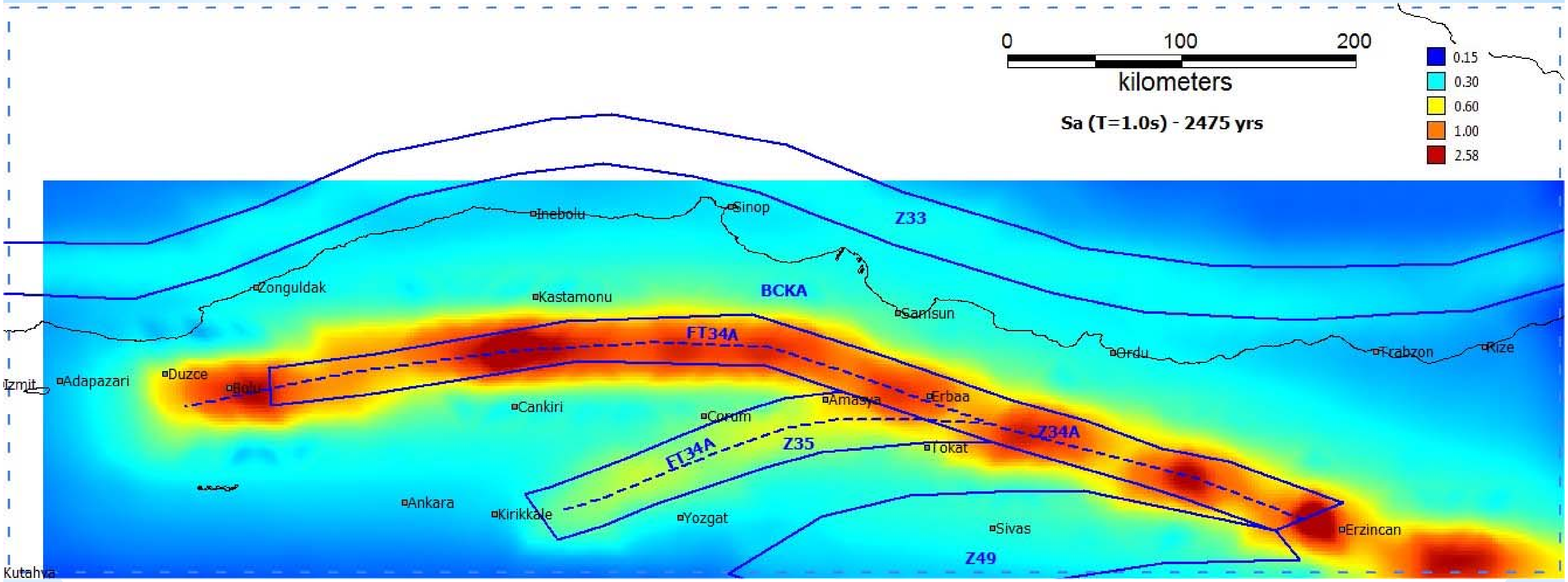
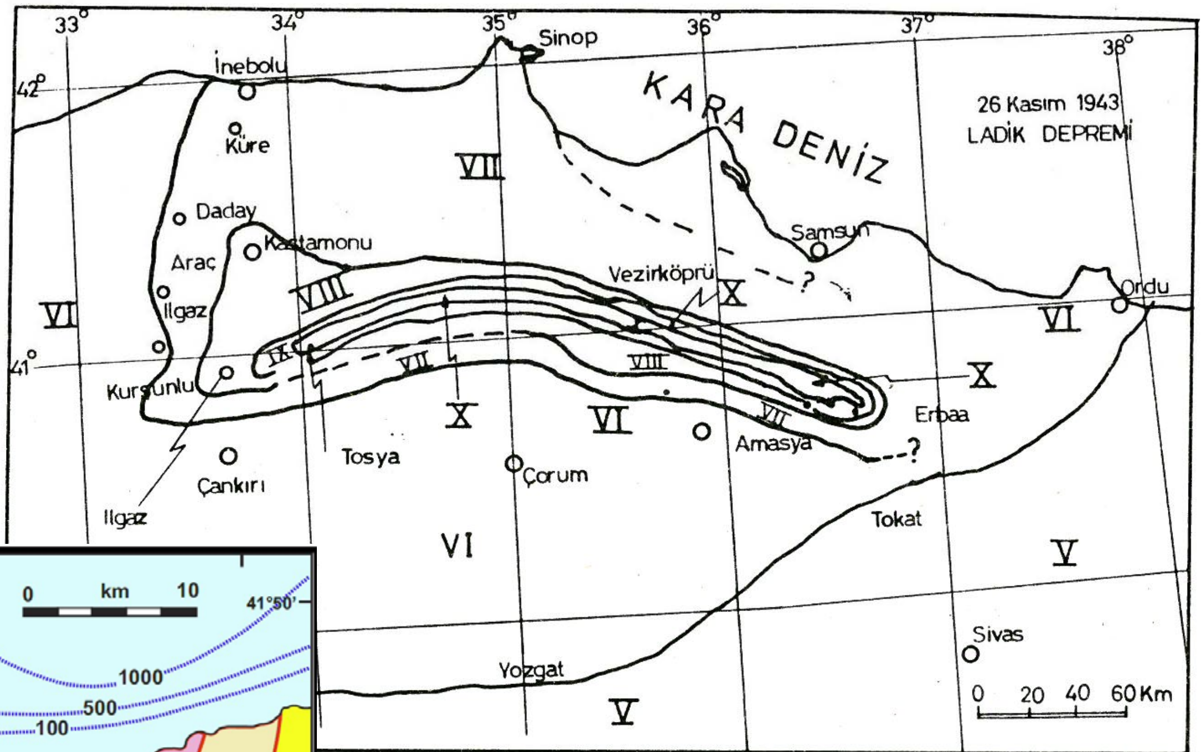
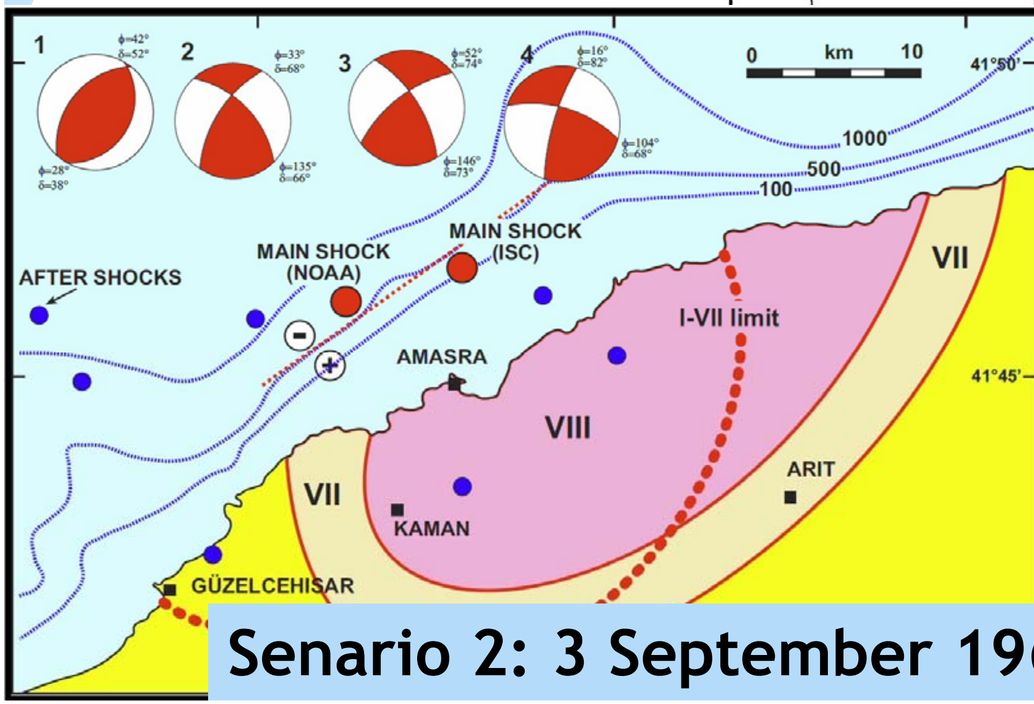


Senario Based Study for SAMSUN region

Senario 1 - 26 November 1943 LADİK EQ. Ms =7.2; Mw7.6

SAMSUN REGION



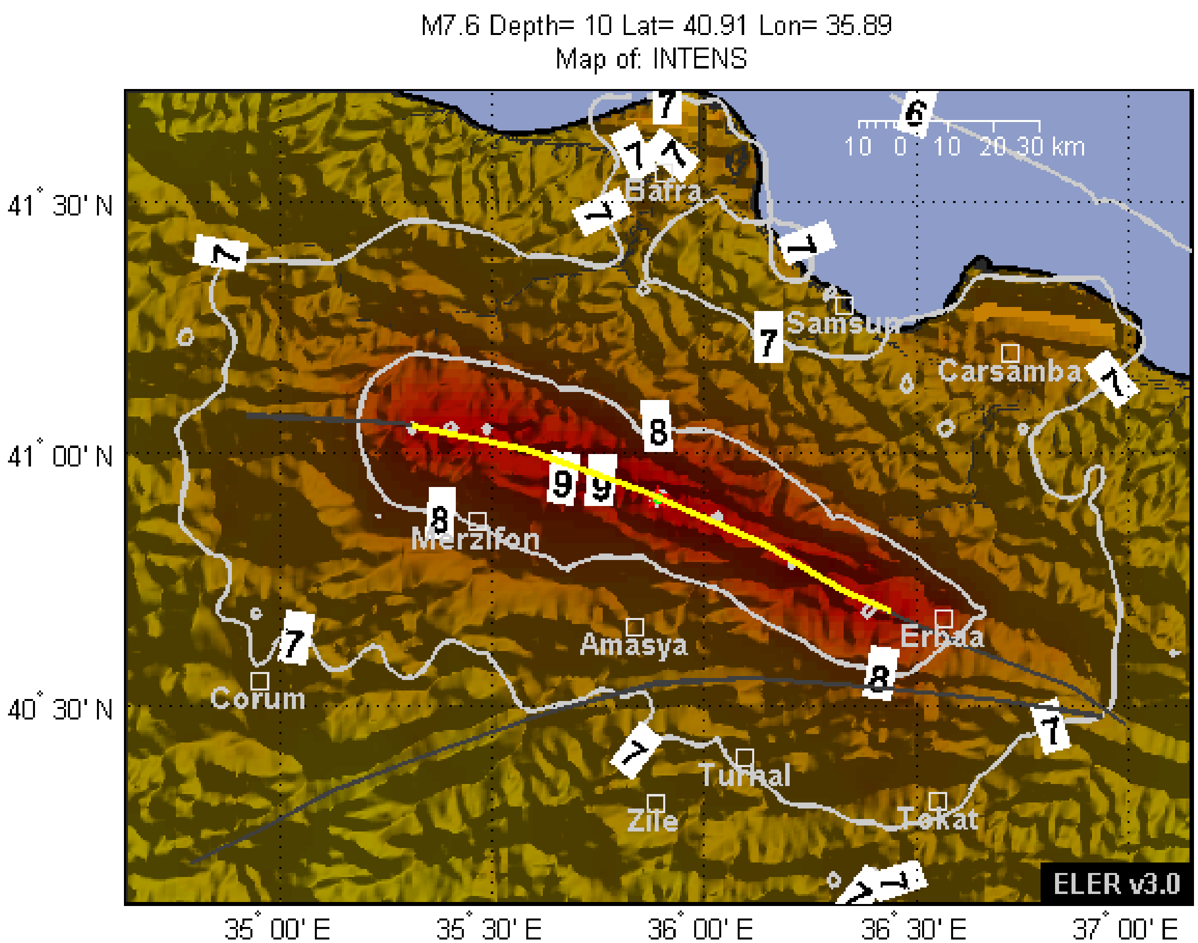


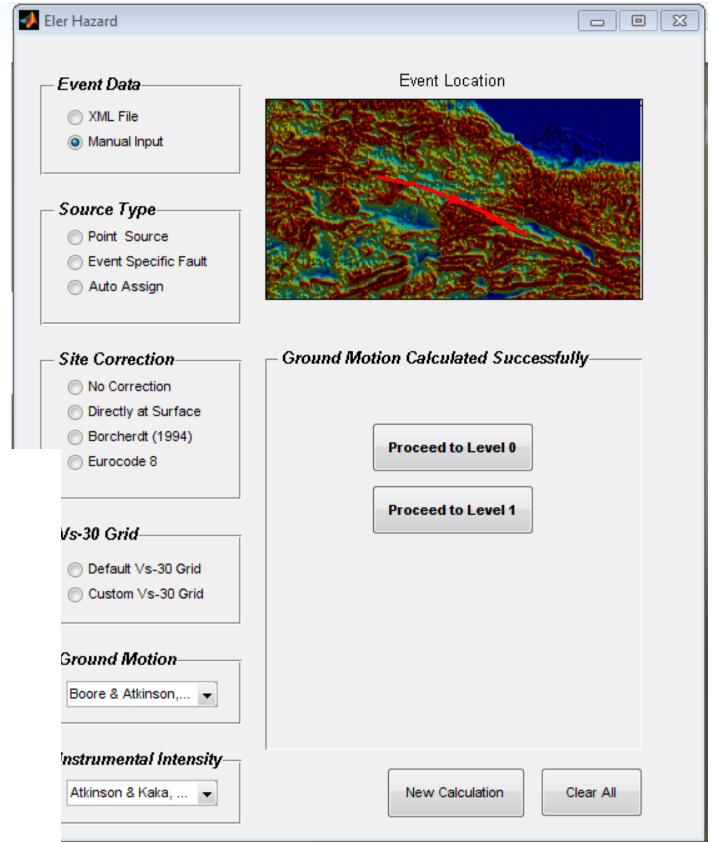
Senario 2: 3 September 1968 BARTIN EQ. Ms=6.6

Senario Based Study for SAMSUN region

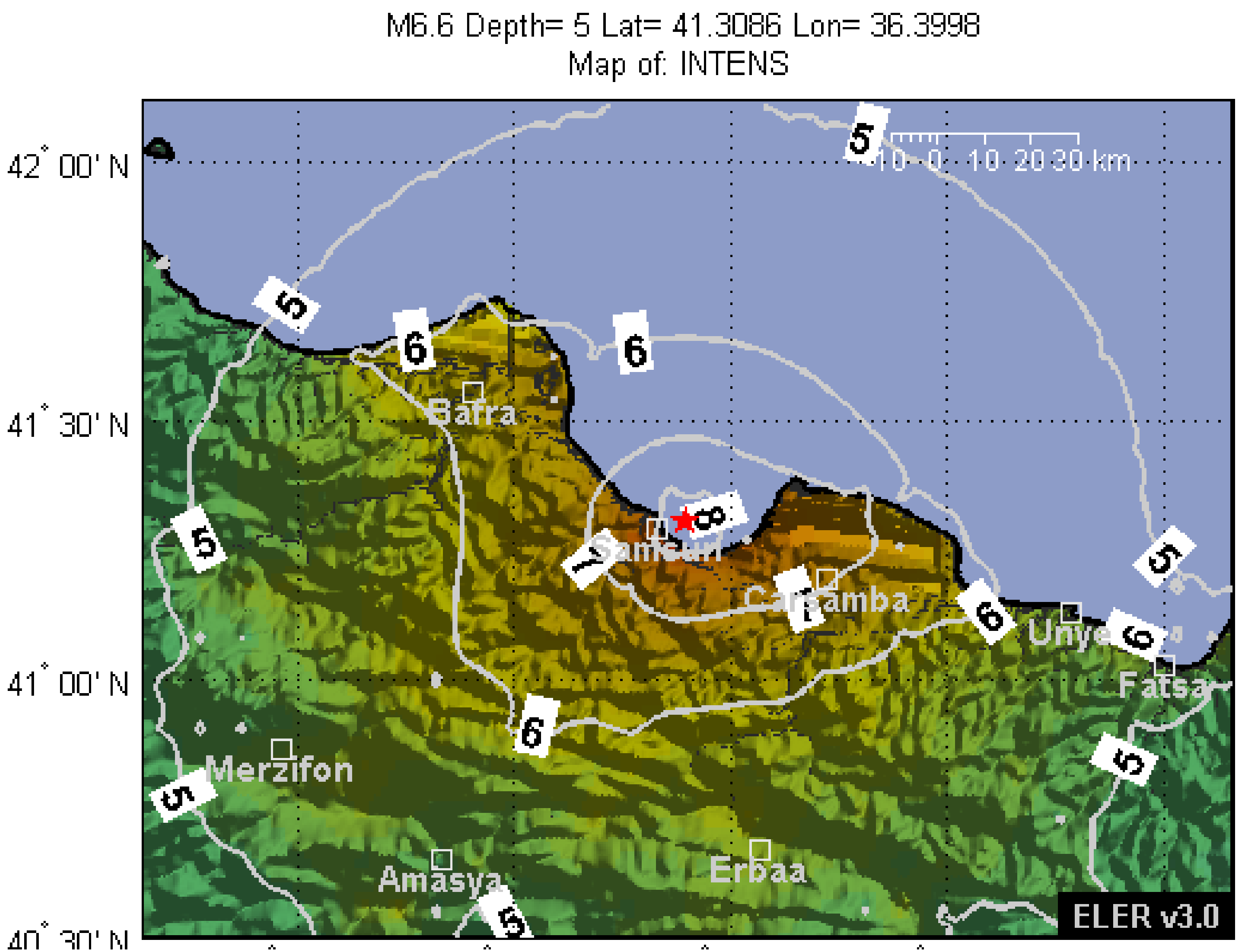
SAMSUN REGION

Senario 1
Southern Samsun - Ladik Eq.
M7.6 - depth 10.0km - Rupture Length =105
Lat: 40.91
Lon: 35.89





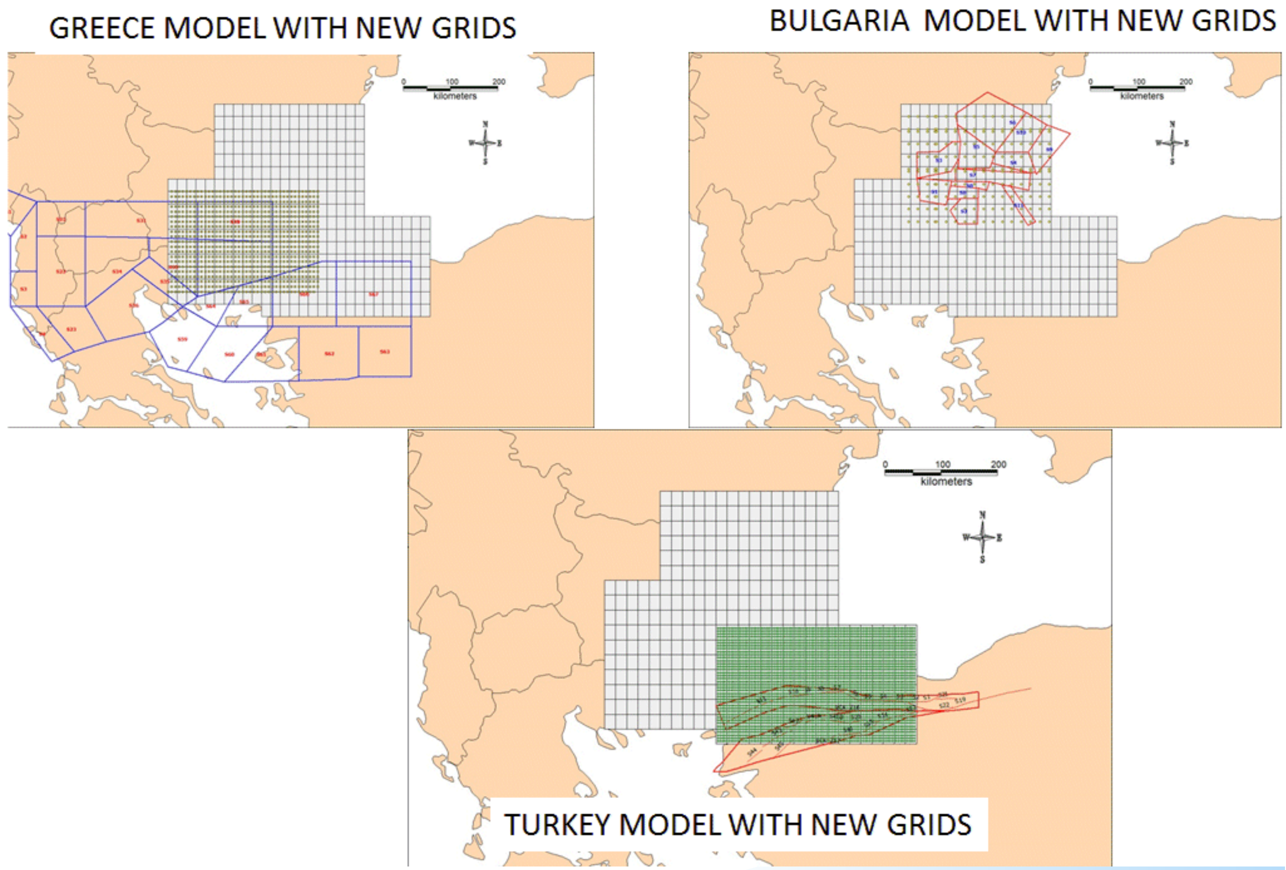
Senario 2 -Bartin Eq. M6.6 Intensity Distribution

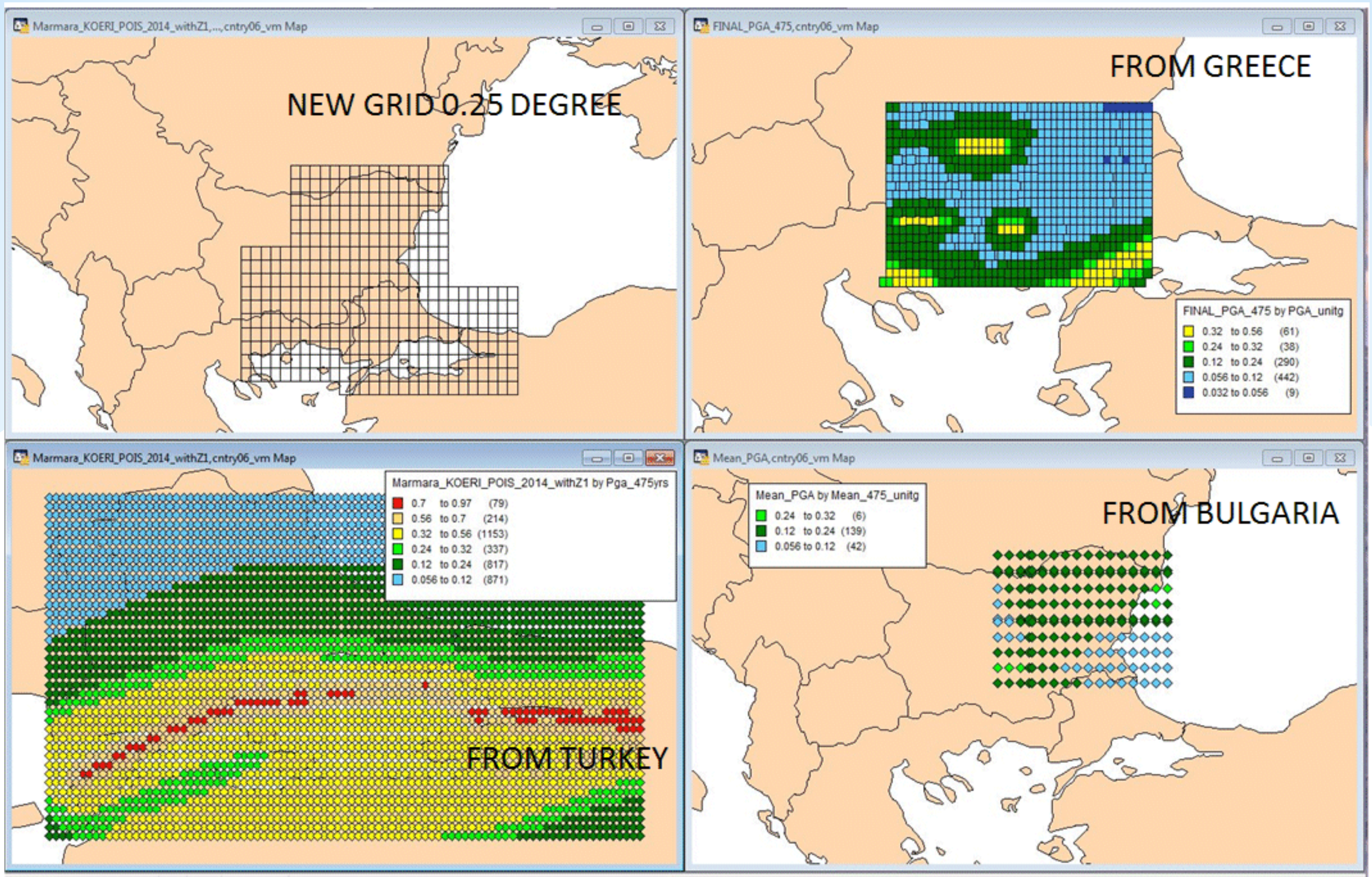


- ✓ The grid based PGA result for the return period of 475 years obtained from PSHA analysis was shared in the other work package to use as an input to landslide analysis

We were generated the grid with 0.25 x 0.25 degree covering all region.
And then, we tried to combine all results for PGA, 475 yrs obtained from PSHA analysis from **Greece**, **Bulgaria,** Moldovia, Romania, Ukrain, and **Turkey.**
The PGA for 475 years values obtained from PSHA for Bulgaria, Greece and Turkey were assigned in the middle of the grid.

0.25*0.25 DEGREE GRID POINTS





PGA - the return period of 475 years

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A Scientific Network
for Earthquake, Landslide & Flood Hazard Prevention

SciNetNatHazPrev – STAKEHOLDERS MEETING

NOVEMBER 12-13, 2015, ISTANBUL, TURKEY

VENUE: MAÇKA SOCIAL CENTER, ISTANBUL TECHNICAL UNIVERSITY FOUNDATION

THANK YOU
FOR YOUR ATTENTION