Earthquake Shaking Potential for Marmara

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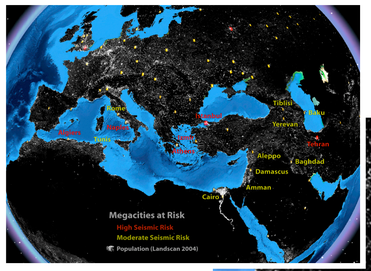
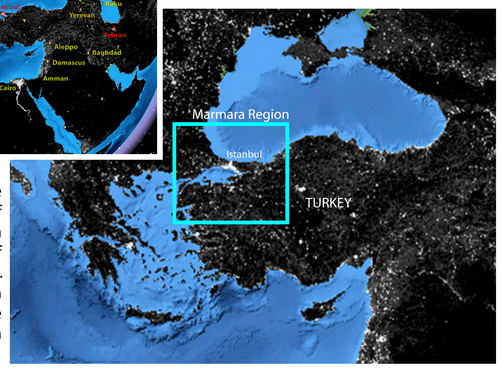
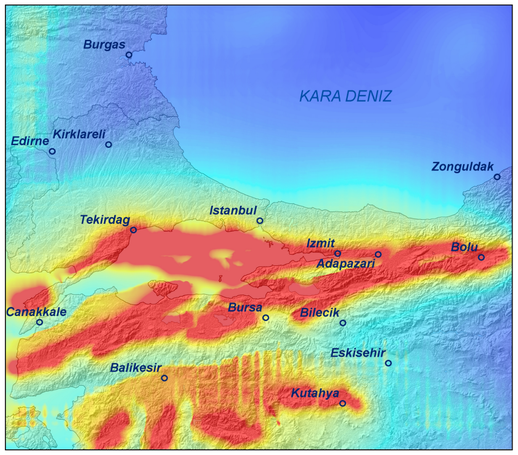
This map shows the expected relative intensity of ground shaking and damage in Marmara from anticipated future earthquakes. The shaking potential is calculated as the level of ground motion that has a 2% chance of being exceeded in 50 years, which is the same as the level of ground-shaking with about a 2500 year average repeat time. Although the greatest hazard is in areas of highest intensity as shown on the map, no region is immune from potential earthquake damage. Expected earthquake damage in Marmarain the next 30 years exceed $30 billion.

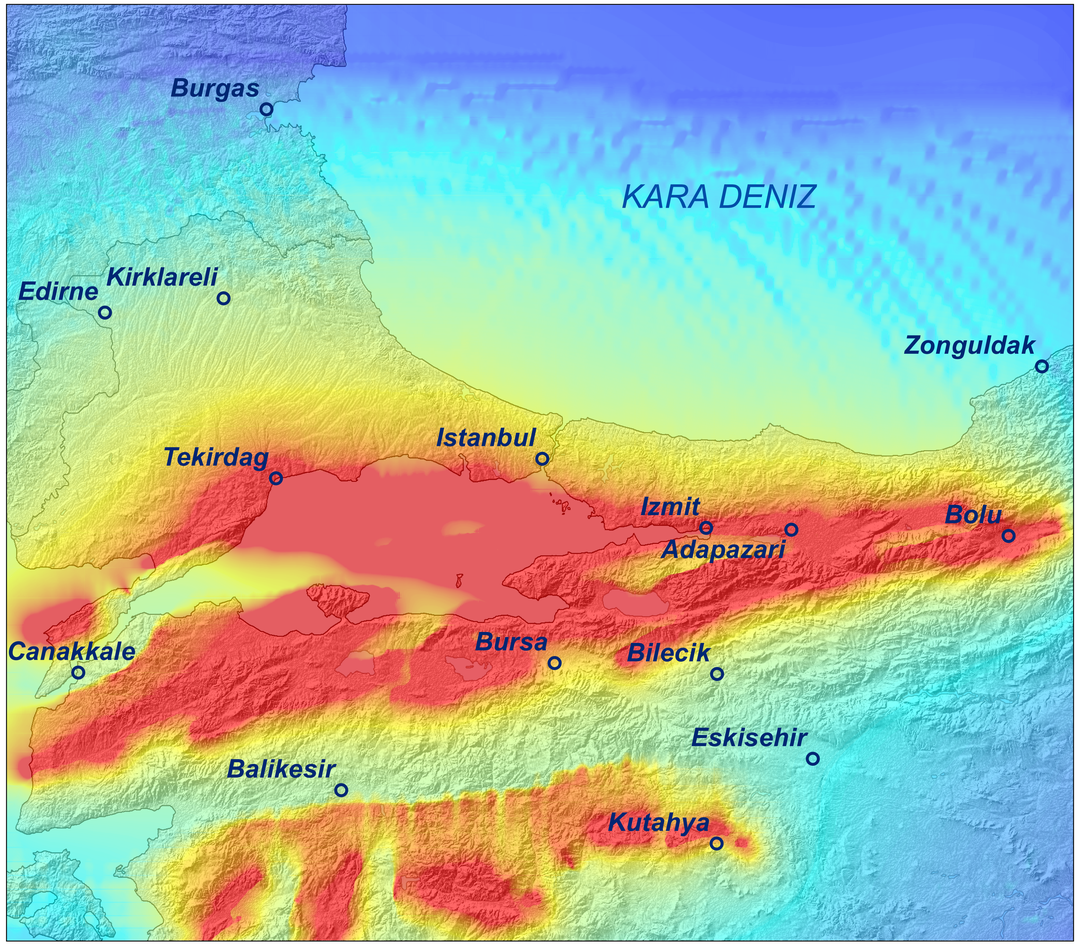




Night time satellite image shows concentration of population in the Marmara region where one third of Turkey's population lives. Istanbul with a population of over 13 million is the most crowded city in Europe.



High frequency shaking potential: Earthquake shaking at 0.2 second period affects short, stiff structures and is also used in estimating future earthquake damage. Local soil conditions have less effect on high frequency shaking.



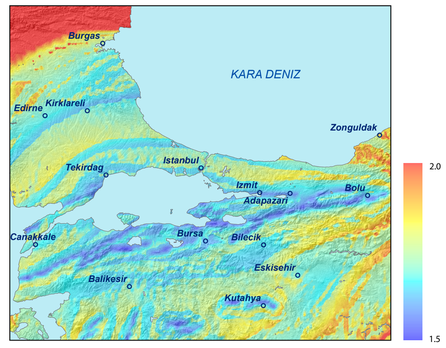
Level of Earthquake Hazard in Marmara (Turkey)

These regions are near major, active faults and will on average experience stronger earthquake shaking more frequently. This intense shaking can damage even strong, modern buildings.

Increasing Intensity

These regions are distant from known, active faults and will experience lower levels of shaking less frequently. In most earthquakes, only weaker, masonry buildings would be damaged. Howere, very infrequently earthquakes could still cause strong shaking here.

Low frequency shaking potential: Earthquake shaking at 1.0 second period affects tall, relatively flexible buildings and correlates well with overall earthquake damage.



Important messages about earthquakes in Marmara

1999 M7.4 Kocaeli and M7.2 Duzce eearthquakes killed 18,000 people, destroyed 15,400 buildings, and caused over $20 billion in losses in Marmara . The next large earthquake may produce even greater losses, especially if it affects a major urban area. Turkey's two largest urban centers, Istanbul and Bursa located in the Marmara region lie in the nations highest hazard zones.

A large earthquake in or near a major urban center in Marmara will disrupt the economy of the entire Turkey. Effective disaster planning by government and local agencies, and by private businesses, can dramatically reduce losses and speed recovery.

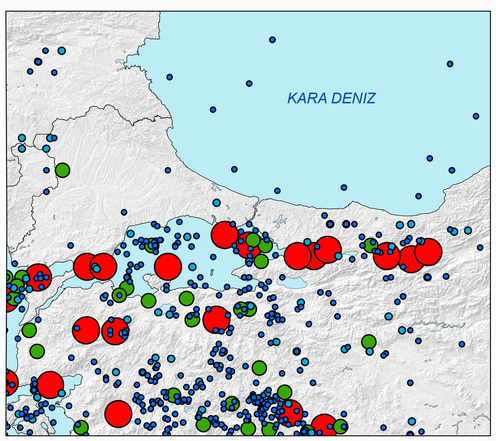
Current building codes substantially reduce the costs of damage from earthquakes, but the codes are intended only to prevent widespread loss of life by keeping the buildings from collapsing, not to protect the building from damage.

If the Kocaeli or Duzce earthquake had occurred closer to Istanbul, fatalities would have been much higher.

After a large earthquake, residents and businesses may be isolated from basic police, fire, and emergency support for a period ranging from several hours to a few days. Citizens must be prepared to survive safely on their own, and to aid others, until outside help arrives.

Maps of the shaking intensity after the next major earthquake will be available within minutes on the internet. The maps will guide emergency crews to the most damaged and will help the public the areas identify the areas most seriously affected.

Earthquake shaking potential is calculated considering historic earthquakes, slip rates on major faults and deformation throughout the region and the potential for amplification of seismic waves by near-surface geologic materials. The complete analysis is called a Probabilistic Seismic Hazard Analysis. The resulting earthquake shaking potential is used in developing building code design values, estimating future earthquake losses and prioritizing earthquake retrofit.



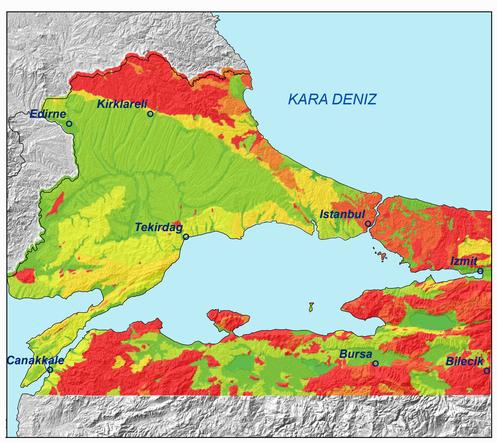
Historic Earthquakes

Magnitude
7+
6-7
5-6
4-5

The rate of historic earthquakes is used to estimate the rate of future earthquakes.

Active Faults

The rate of earthquakes on faults is governed by the size of the fault and the rate that one side moves relative to the other. Larger faults can have larger earthquakes and faults with higher slip rates can have more frequent earthquakes.



Surface Geologic Materials

Surface Shear Wave Velocity of Upper 30 meters (m/s)

0 - 150
150 - 200
200 - 250
250 - 300
300 - 400
400 - 500
500 - 600
600 - 700
700 - 800

Seismic waves may be amplified by near surface materials. Soft soils, those with low shear wave velocity, amplify shaking compared with hard rock with high shear wave velocity. A geologic map of Marmara showing units with different shear wave velocity can be used to estimate seismic amplification.

Local soil conditions have greater effect on low frequency shaking, the above map shows ratio of round motion estimate between soft soil (VS30 = 180 m/s) rock (VS30 = 760 m/s).

Reference

Kalkan E. Gulkan P. Ozturk N.Y. Celebi M. "Re-Examination of Probabilistic Seismic Hazard in the Marmara Sea Region", *Bulletin of Seismological Society of America*, Vol. 99, No. 4, pp. 2127–2146, August 2009.

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