

- ### Precursors and Time framework
- Based on the buildup of stress along the fault zone south of Izmit the possibility of a large ( $M_w > 6.7$ ) earthquake was 12 % in the period between 1997-2027
  - No reliable precursors
  - Geological and meteorological
    - Lights in the sky
    - Small tsunamis in the black sea

- ### Pre-event disaster preparation by authorities and awareness of the population
- Building regulations for the EQ prone areas
    - Not enforced
  - People were aware of the possibility of an EQ

## Scale of the event and the disaster

- August 17, 1999 at 3:02 a.m. in Izmit EQ  
Mw 7.4 caused by rapture of Earth's surface along western part of Anatolian fault
  - 17, 127 dead, 43, 953 injured, 250, 000 displaced
  - 20, 000 buildings destroyed
  - 214, 000 residential units and 30, 500 businesses damaged
- Property losses estimates in 1999 from \$3 to \$6.5 billion

## Scale relative to other disasters

Table 8-1 Some of the Most Catastrophic Earthquakes in Terms of Casualties

Earthquake	Date	Magnitude (M <sub>s</sub> )	Casualties	Probable Cause
Somaria	Dec. 26, 2004	9.0	>200,000 (including missing) in a great vacuum caused by the tsunami	Subduction zone
Iran, Bam	Dec. 26, 2003	6.7	>24,000, most in buildings of mud and brick	Strike slip motion, extension, occurred on basin; irregular blind thrust
India, Bhuj	Jan. 26, 2001	7.7	>50,000, most in buildings of mud and brick	Transform fault
Turkey, Izmit	Aug. 17, 1999	7.4	>50,000 in poorly built, masonry buildings	Continuum extension collision
Iran	June 20, 1990	7.7	>10,000, most in hospitals and collapse of stone and unreinforced masonry houses	Continuum extension collision
Armenia	Dec. 7, 1988	7.0	25,000, mostly in process, poorly constructed concrete-frame buildings	Continuum extension collision
China, Tangshan	July 27, 1976	7.6	230,000, mostly in collapsed office houses	Strike slip motion
Peru	May 31, 1970	7.8	66,000 in rock slide that destroyed towns	Subduction zone
Chile, Chillan	Jun. 24, 1939	7.8	30,000	Subduction zone
India, Quana	May 31, 1935	7.5	60,000	Subduction zone
Japan, Kanto	Sept. 1, 1923	8.2	84,000, including in great Tokyo, but caused by other slip	Subduction zone
China, Kanto	Dec. 16, 1920	8.5	100,000	Thrust fault (collision)
Italy, Anagni	Jan. 13, 1915	7	30,000	Normal fault
Italy, Sicily, Messina	Dec. 28, 1908	7.3	120,000	Subduction zone
Ecuador and Colombia	Aug. 16, 1868	?	70,000 (most 40,000 in Ecuador); 30,000 in Colombia	Subduction zone
Japan, Echigo	Dec. 16, 1828	?	40,000	Subduction zone
Indonesia, Opium	Feb. 6, 1797	?	40,000	Subduction zone
Italy, Calabria	Feb. 4, 1783	?	50,000	Subduction zone
Portugal, Lisbon	Nov. 1, 1755	?	70,000 (including in a great tsunami) caused by the earthquake	Continuum extension collision?
Northern Peru	June 7, 1753	?	40,000	Continuum extension collision
India, Calcutta	Oct. 15, 1757	?	300,000	
Italy, Catania	Jan. 11, 1693	?	60,000	
Caribbean, St. Domingue	Nov. 1487	?	50,000	
C'ho, Taiwan, Sitan	Jan. 23, 1536	?	83,000, mostly in collapse of houses dug into basin	
Portugal, Lisbon	Jan. 25, 1531	?	37,000	
Japan, Kamakura	May 26, 1299	?	30,000	Subduction zone



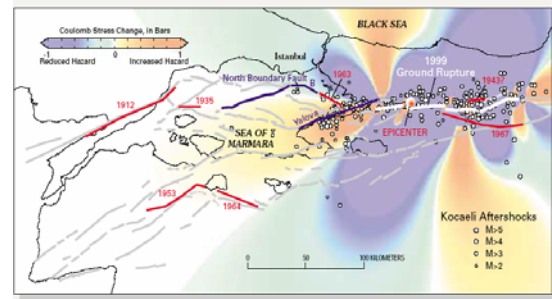
## Extent of damage



## Disaster effects

- Aftershocks
- Liquefaction
- Surface faulting
- 250 000 people lost their homes

## Aftershocks



## Liquefaction



## Surface faulting

- Slip right lateral up to 5m (max) normally 2.5-4m;
- At the shore normal faulting with a slip component resulted in subsiding of 2-3m of 4km of the shoreline



## Surface faulting



## Trans European Motorway



## Subsidence of the coast line



## Actions that could have reduced losses

- Limit the development in areas along the Anatolian fault
- Enforcing the building code
  - Appropriately reinforced concrete or wood frames
  - Prevent building garages and storefronts on the first floor

## References

- [http://www.eas.slu.edu/Earthquake\\_Center/TURKEY/#home1](http://www.eas.slu.edu/Earthquake_Center/TURKEY/#home1)
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- Hyndman and Hyndman, (2005). Natural hazards and disasters. Thompson Brooks/Cole
- Whithead, N. E., Ulsay, U., Asahara, H., and Ikeaya, M., (2004). Are there any public-reported earthquake precursors valid?. *Natural Hazards and Earth System Sciences.*, 4:463-468