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Present, Past, Future - What earthquake clusters can tell us about an upcoming Marmara Sea earthquake

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Earthquake clusters are a worldwide observation, especially with respect to large events in terms of their respective aftershock sequences. These clusters contain a lot of information about the general seismicity of the region and follow various magnitude and location-dependent characteristics. Using the seismic record of smaller magnitudes in the aftermath of large earthquakes, these details can be used to extrapolate these characteristics and to simulate the unrecorded cluster activity of historic earthquakes.
The Marmara Sea is prone to frequent strong seismicity, most recently experienced by the destructive Izmit earthquake in 1999 and several historic events with frequent return periods of only a few centuries. For the future, such an event is expected in the area of Istanbul. The city has already experienced several earthquakes over its long history, such as in 1509, when major parts of Constantinople were destroyed or severely damaged. The fault system in the Marmara Sea is very complex, but based on the distribution of fault ruptures during the last 500 years, a seismic gap is visible and experts around the world see an increased probability of a strong earthquake in the vicinity of Istanbul for the next decades.
The seismicity and characteristics of clusters around the Marmara Sea and along the North Anatolian fault have been studied. The activity of these clusters, recorded during the last decades, is used to model the spatial and temporal distribution of aftershocks of historic events. In addition, a fault model is used and combined with the results of the cluster analysis to elongate the synthetic earthquake locations to active tectonics. The results are correlated and calibrated with the observed macroseismic intensity distribution of each historic event. With respect to recent ruptures, several scenarios are modelled for future events including and compared in terms of their respective ground accelerations. As a result, a new collection of possible ground acceleration maps is presented and an expectation for the magnitude-dependent aftershock activity which is based on a correlation and extrapolation of earthquake clusters around the Marmara Sea.
This type of scenario building approach provides a more detailed basis for risk assessment and management planning with a more realistic scenario providing better analysis and socioeconomic effect study potential in the next disaster.