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The role of deterministic analyses and seismotectonic data in earthquake risk assessment, Istanbul, Turkey.

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Seismotectonic methods allowing quantitative measures of the frequency and severity of earthquakes have greatly advanced over the last 30 years, aided by high-resolution imagery, digital topography and modern techniques for dating. During the same period, deterministic models based on the physics of earthquakes (Coulomb stress interactions) have been extensively developed to explain the distribution of earthquakes in space and time. Seismotectonic data and Coulomb Stress models provide valuable information on seismic hazard and could assist the public policy, disaster risk management and financial risk transfer communities to make more informed decisions around their strategic planning and risk management activities.

The Sea of Marmara and Istanbul regions (North Anatolian Fault, NAF) are among the most appropriate on Earth to analyse seismic hazard, because reliable data covers almost completely two seismic cycles (the past $\sim$500 years). Earthquake ruptures associated with historical events have been found in the direct vicinity of the city, on the Marmara sea floor. The MARMARASCARPS cruise using an unmanned submersible (ROV) provides direct observations to study the morphology and geology of those ruptures, their distribution and geometry. These observations are crucial to quantify the magnitude of past earthquakes along the submarine fault system (e.g. 1894, 1912, 1999, M $>$ 7). In particular, the identification of a break continuous over 60 km with a right-lateral slip of 5 m, corresponding probably to the offshore extension of the Ganos earthquake rupture (1912, Ms 7.4), modifies substantially our understanding of the current state of loading along the NAF next to Istanbul.

Coulomb stress analysis is used to characterise loading evolution in well-identified fault segments, including secular loading from below and lateral loading imposed by the occurrence of previous earthquakes. The 20^{th} century earthquake sequence in the region of Istanbul is modelled using geological and geophysical records. For the 18^{th} century M$\geq$7.0 earthquake clusters, we construct scenarios consistent with the tectonic and historical data. Coulomb stress modeling including the 20^{th} and 18^{th} century historical events shows a current zone of maximum loading along a 70 km long strike-slip segment, south-west of Istanbul, with at least 4-5 m of slip deficit. That segment alone would be capable of generating a large magnitude earthquake (Mw 7.2). Other segments in Marmara appear less loaded.