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A newly discovered seismic hazard zone in the Cilician Taurus, Southern Turkey: Implications for the planned nuclear power plant

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Earthquakes on previously undiscovered faults or on the faults with unknown slip rates can potentially lead to significant hazard. A recent case was the 2011 Christchurch ML 6.3 earthquake that claimed 185 lives and substantial damage. The earthquake occurred on a previously undiscovered fault at a depth of 5 km and is considered one of the nation's deadliest peacetime disasters. Buried earthquake sources on which the earthquake occurrence period is long can be fatal and they are especially difficult to detect. In this study we analyse geodetic data in central and southern Anatolia using a novel mathematical technique and conclude that a seismic risk zone of similar character exists in southern Turkey, to the north of the coastal region where Turkey plans to build a nuclear power plant.

South & central Turkey lies between the influence of two end-member tectonic processes: Arabia - Eurasia collision in the east and Hellenic subduction to the west. The stalled subduction of the Cyprus Arc exerts compression from the south on the overriding Anatolia, thereby creating compressive stresses along the southern Turkish coast. Consequently, this region constitutes the transition between shortening and extensional domains, and thought to be undergoing very little, if not any, deformation. The resultant tectonic regime has a transtentional character. Nevertheless, along the southern coast (southern margin of the Taurus mountains) there is scarce evidence of active faulting. Two exceptions are the Ecemis fault and its antithetic Tuzgolu fault, both strike-slip faults, the former bounding the Cilician Taurus from the west.

The standard approach to such a problem is a kinematic one and it consists of calculating strain-rates from GPS velocity data. As opposed to the standard approach, here we tackle the problem using the vertical derivatives of horizontal stress (VDoHS) rates (Dimitrova et al., 2012), which is especially efficient in determining zones of deformation along faults without slip rate information mapped from palaeo-seismicity or along completely hidden faults. We used GPS campaign data across central Anatolian block, gathered between 1998 and 2006. Our analysis shows significant contractional force area strain within Cilician Taurus. Our results show also large extensional force area strains coinciding with the northern part of the Tuzgolu fault. The signature across the Cilician Taurus is very significant and may potentially indicate an ongoing hidden deformation field that may facilitate stress accumulation in the long term. This possibly has far-reaching implications on the hazard mapping of the region and the nuclear safety for the entire eastern Mediterranean. The present analysis can be used to construct synthetic earthquake source models which, in turn, can be used in theoretical strong motion studies for the planned site for the nuclear power plant on the southern coast.