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1755 AND THE NEW EUROPEAN SEISMIC HAZARD MAP

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The recent publication of the new European Seismic Hazard Map (Giardini et al., 2013) highlights once more the disparity between common assumptions regarding the contribution of the M8.5 1755 Lisbon earthquake to the seismic hazard in Lisbon, on one side, and the estimates of probabilistic seismic hazard assessment. The issue is not simply academic, since said assumptions are at the basis of current Portuguese regulations. The traditional model adopted for this major earthquake has an epicentral area located SW of Cape St Vincent, a few hundred km from the Lisbon area. At the regulatory return period of 475 years, but also at the longer return periods, the contribution of such a seismic source to the seismic hazard in Lisbon is hardly noticeable with any combination of published GMPE's, a result visible again in the new European Seismic Hazard Map. This notwithstanding, in the hazard assessment used for the EUROCODE 8 national document for Portugal that distant scenario drives the hazard in Lisbon at 475 years of return period. Disaggregation attempts during the preparation of the European Seismic Hazard Map (Danciu, pers. comm.) failed to warrant this assumption. This incoherency raises a challenge that in our view should not go unanswered, given the European dimension of this earthquake. A negative side effect of such discrepancy is the tendency by some risk analysts to assign the extreme damage in Lisbon to other causes such as fire (e,g., Franco and Sheng-Tu, 2009), whereas the coeval accounts document that it was due mostly to ground shaking.

Even when no new evidence emerges concerning an historical earthquake, the steady progress of our understanding of seismogenesis makes it advisable to revisit regularly the available data. Since the 1755 Lisbon Earthquake plays a key role in any study of the seismic hazard of mainland Portugal, such re-evaluation is also required in order to maintain a state-of-the-art hazard assessment. Recently, Pro et al. (2013) studied the seismotectonics of the offshore region SW of Cape St Vincent, and proposed the combined rupture of three seismogenic structures to accommodate the requirement of an extremely large rupture area implied by the M8.5 magnitude usually attributed to the 1755 earthquake. However, the near end of the nearest structure to Lisbon is still 260 km away. Pro et al. (2013) tentatively invoke source directivity as an explanation for the concentration of damage in Lisbon, but this is problematic in our view because strong velocity pulses caused by constructive interference associated with rupture propagation have been observed in the near field only, typically up to 20 km away from the fault (Tothong et al., 2007; Shahi and Baker, 2011).

We argue that recent observations of stress triggering (Pollitz et al., 2012; Stein and Toda, 2013) reinforce the arguments put forward by Vilanova et al. (2003) in favour of a triggered onshore rupture near Lisbon, in the Lower Tagus Valley Fault System, a set of active faults under investigation to assess its full seismogenic potential (Vilanova and Fonseca, 2004; Besana-Ostman et al., 2012). Historical data attest that this fault system is capable of producing moderate to strong earthquakes, including the one that destroyed Lisbon and other towns along the Lower Tagus Vallley in 1531. We will revisit some of the arguments of Vilanova et al. (2013), under the light of recent observations.

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But, above all, we encourage the search for alternative – quantitative - explanations for the extreme effects of this historical earthquake in Lisbon. A thorough investigation of this poorly understood phenomenon should then be followed by the revision of the seismic zonation underlying the national document for EUROCODE 8, made obsolete by several published studies, including the new European Seismic Hazard Map.

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