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Factors controlling the distribution of building damage in the traditional Vrissa settlement induced by the 2017 June 12, Mw 6.3 Lesvos (Northeastern Aegean Sea, Greece) earthquake

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On June 12, 2017 (12:28 GMT), an Mw 6.3 earthquake struck Lesvos Island (Northeastern Aegean, Greece). Its epicenter was located offshore southeastern Lesvos along an offshore NW-SE striking and SW-dipping normal fault as it is indicated by the provided focal mechanisms and the spatial distribution of the aftershock sequence (UOA).

Building damage was localized in the western part of the affected area and more specifically in Vrissa village. The very heavy structural damage was observed in its western part, while its eastern part remained relatively intact. Taking into account the geological setting of Vrissa, it is concluded that its worst affected western part is founded on Holocene alluvial deposits (clays, sands, gravels), while its slightly affected eastern part is founded on Pleistocene deposits (fluvial sands, clays, conglomerates) with thickness of about 100 m. Moreover, the groundwater level in the alluvial deposits was high resulting in reduction of (a) the absorption of the vertical (P) waves, (b) the strength and the stiffness of the soils due to the fact that the water acts as lubricant reducing friction and increasing mobility of deposits and (c) the generation of the S waves due to saturated deposits. All the aforementioned facts led to large differences in seismic intensities between the two parts of Vrissa.

Apart from the worst affected western part, very heavy structural damage including partial or total collapses was also observed in isolated areas in the relatively intact part. The most characteristic damage islet has been detected around the partially collapsed elementary school of Vrissa. It is characterized by partial or total collapse of masonry buildings of old construction age and high vulnerability as well as by damage to infrastructures and more specifically to the road and electricity networks. This damage islet is attributed to the generation of landslides along a detected geotechnically unstable zone with relatively steeper slopes characterized by generation of coseismic landslides. For example, a landslide was generated southeast of the school resulting in destruction of the road network and tilting and collapse of electricity pillars. Another landslide was observed in the southern part of the school resulting in hairline cracks to a masonry perimeter wall located in the westward prolongation of the crown cracks, partial collapse of a retaining wall supporting the school's playground and severe damage to a warehouse adjacent to the unstable and mobilized slope inside the school's yard. It is significant to note that this is not the first time that landslides have been generated in the same site. Evidences of generation of similar phenomena were detected on an adjacent perimeter wall that suffered cracks and were repeatedly restored with the use of concrete.

It is concluded that the geological, geomorphological and geotechnical setting along with the building characteristics have been identified as factors controlling the spatial distribution of building damage. Specifically, highly vulnerable old structures founded on alluvial deposits and on slopes in an area bounded by significant faults and geotechnically unstable zones in combination with probable directivity phenomena resulted in destruction.