Seismic hazard assessment accounting for earthquake-induced phenomena through spatial multi-criteria analysis in Xerias torrent basin, Greece

The present study focuses on the area of the Xerias torrent drainage basin, located at Northeastern Peloponnese, Greece. The study area is situated at the eastern part of the Gulf of Corinth, an active tectonic rift, characterized by high seismic activity and intense extension which is accommodated by a series of major active normal faults. As a result, it has frequently suffered damage from earthquakes which in some cases were accompanied by seismically-induced phenomena. These secondary phenomena include landslides and soil liquefaction and in some cases have the potential to cause more damage and casualties than the earthquake itself. Classic deterministic and probabilistic approaches of seismic hazard assessment do not account for seismically-induced phenomena and accordingly such analyses overlook locations prone to these secondary effects. The aim of our research is to evaluate seismic hazard not only as the hazard associated with the occurrence of potential earthquakes in the particular area, but also assess areas exposed to slope destabilization phenomena and soil liquefaction under seismic shaking. For this purpose we will use the pure statistical and the semi-statistical seismic hazard approaches along with the Analytic Hierarchy Process (AHP) to estimate the susceptibility of the study area to earthquakes and their triggering effects. AHP is a multi-criteria decision making method that helps to deal with a complex problem taking into account multiple conflicting criteria. The extent of the study area is limited, so classic probabilistic seismic hazard assessment yields a uniform seismic hazard throughout the study area. Afterwards, we evaluated separately the hazard from seismically-induced landslides and soil liquefaction and subsequently we stacked them into one single hazard map reflecting the hazard due to seismically-induced phenomena. Such map complement the standard PSHA maps and highlight areas that need special attention by planners and authorities so as to mitigate not only the consequences of earthquakes but also their secondary effects.

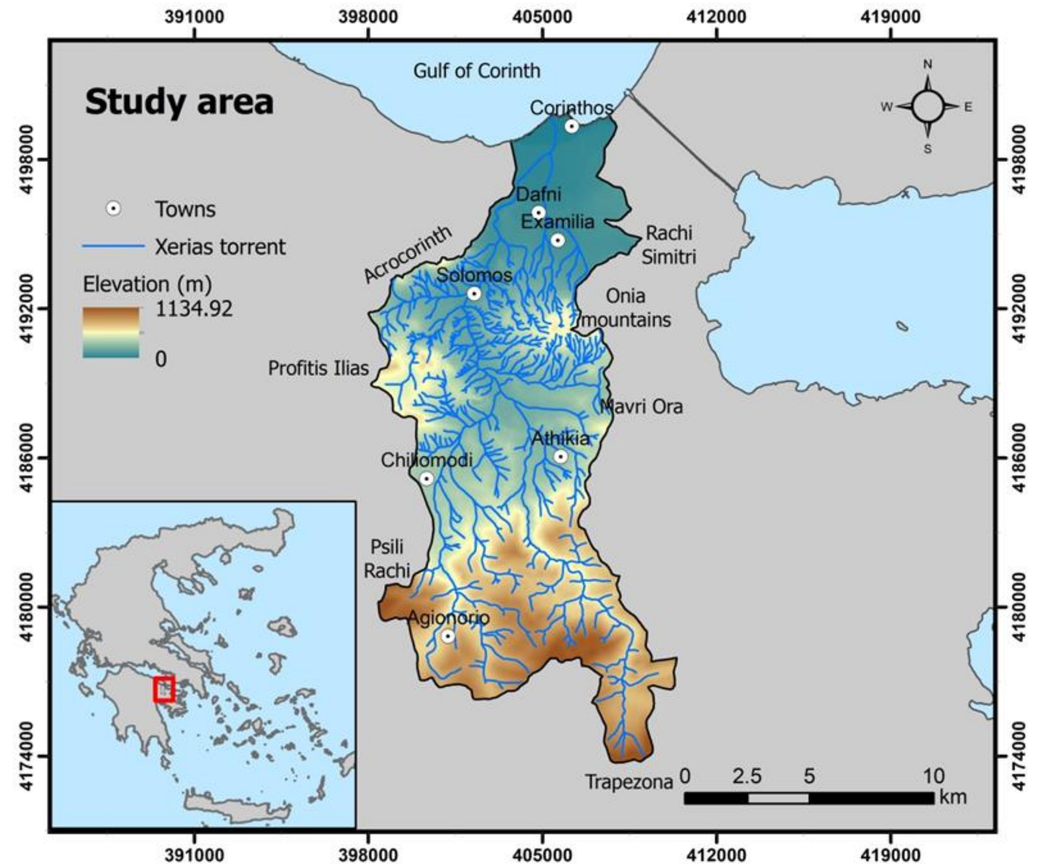

Figure 1. The digital elevation model (DEM) of the Xerias drainage basin superimposed by the Xerias torrent, the main towns and the. The red rectangle in the inset highlights the location of the study area within the Greek territory.

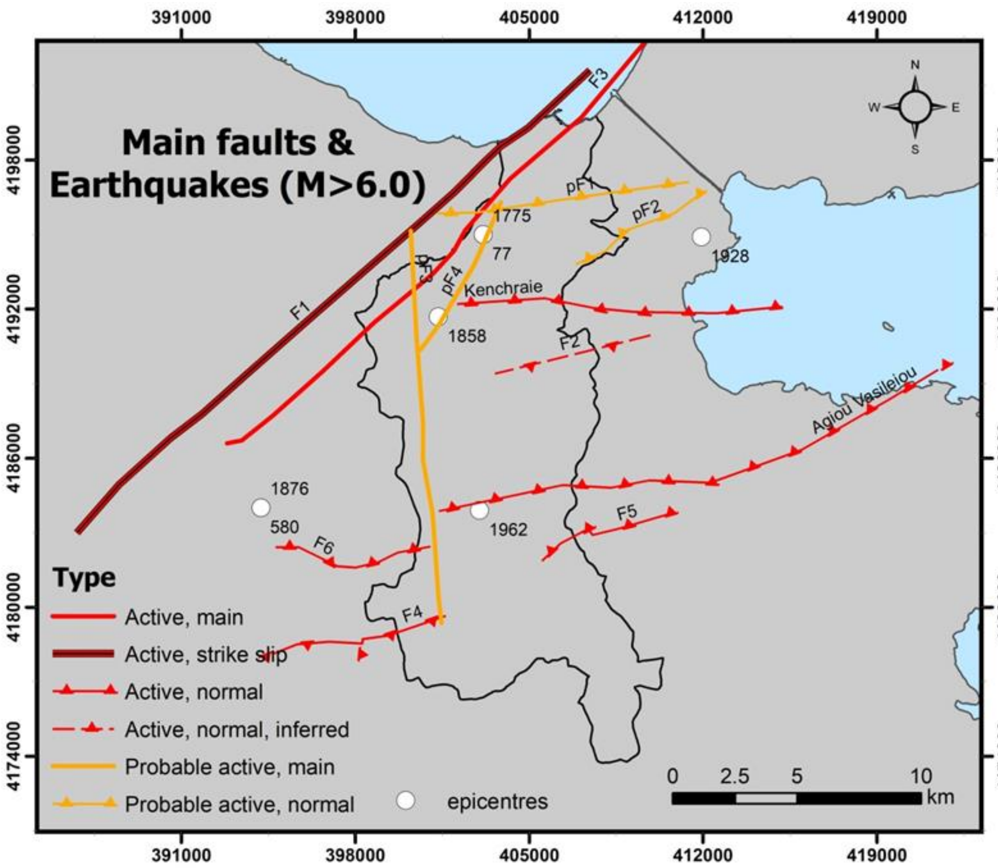

Figure 2. Map of the study area showing local active and probable active faults (E.P.P.O. Neotektonic map “Korinthos” sheet 1:100.000) along with the epicenters of historical and instrumentally recorded major earthquakes (Ms>6.0) (Ambraseys & Jackson 1990, 1997; Papazachos & Papazachou 2003).

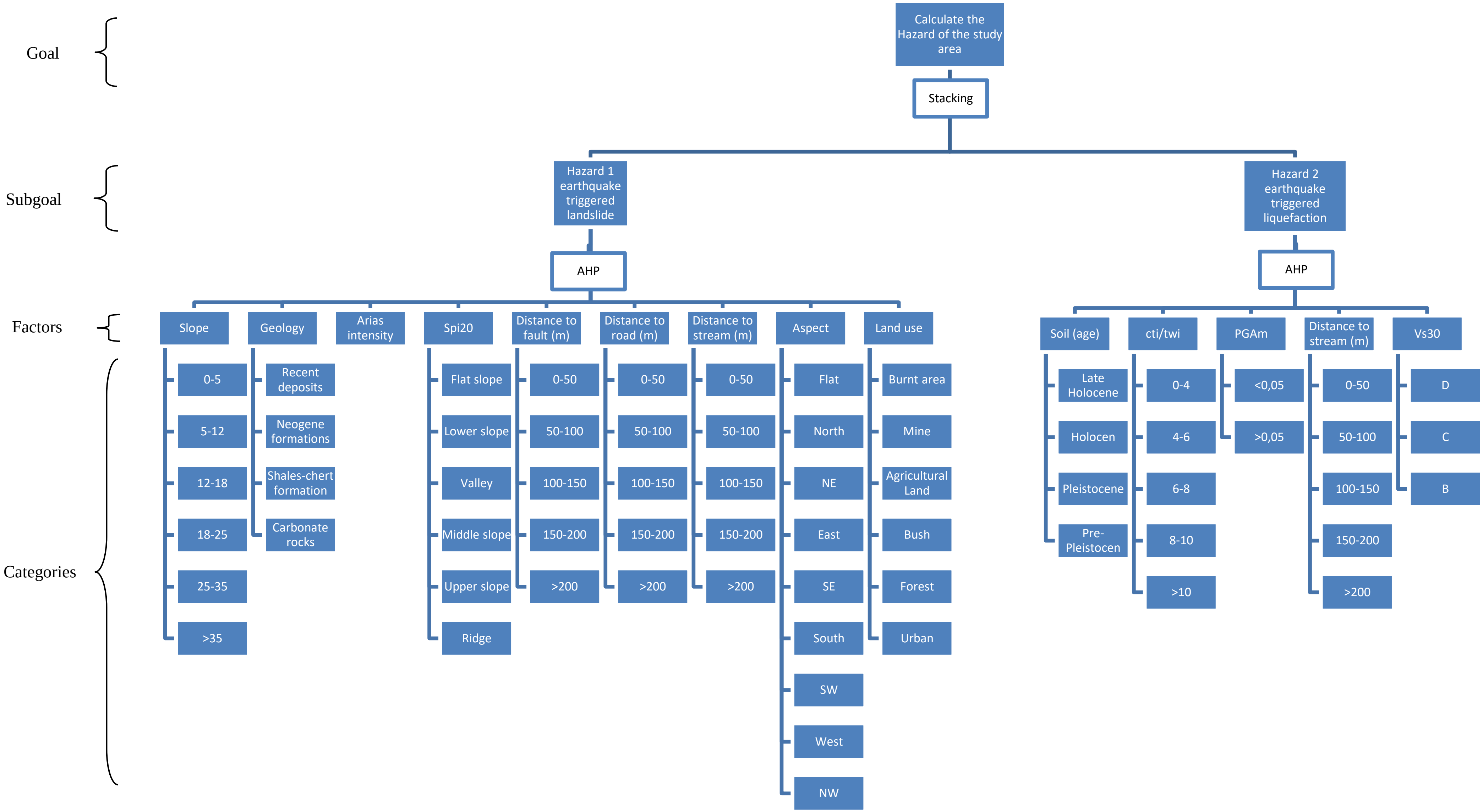

Figure 3. Workflow of the adopted approach for the hazard assessment of earthquake-induced phenomena

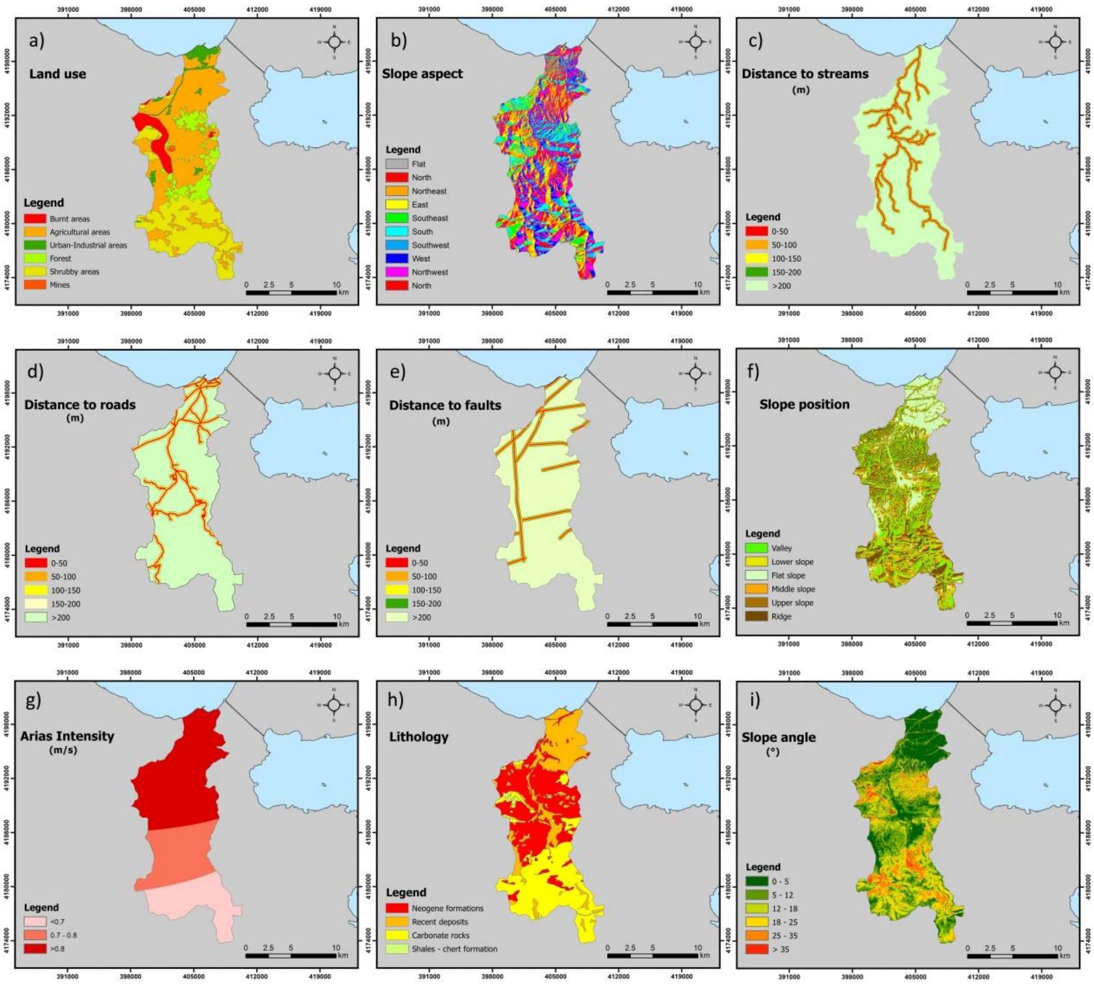

Figure 4. Thematic layers of the causative factors that contribute to the likelihood of earthquake-induced landslides. a) Land use, b) slope aspect, c) distance to streams, d) distance to roads, e) distance to faults, f) slope position, g) Arias Intensity, h) lithology, and i) slope angle.

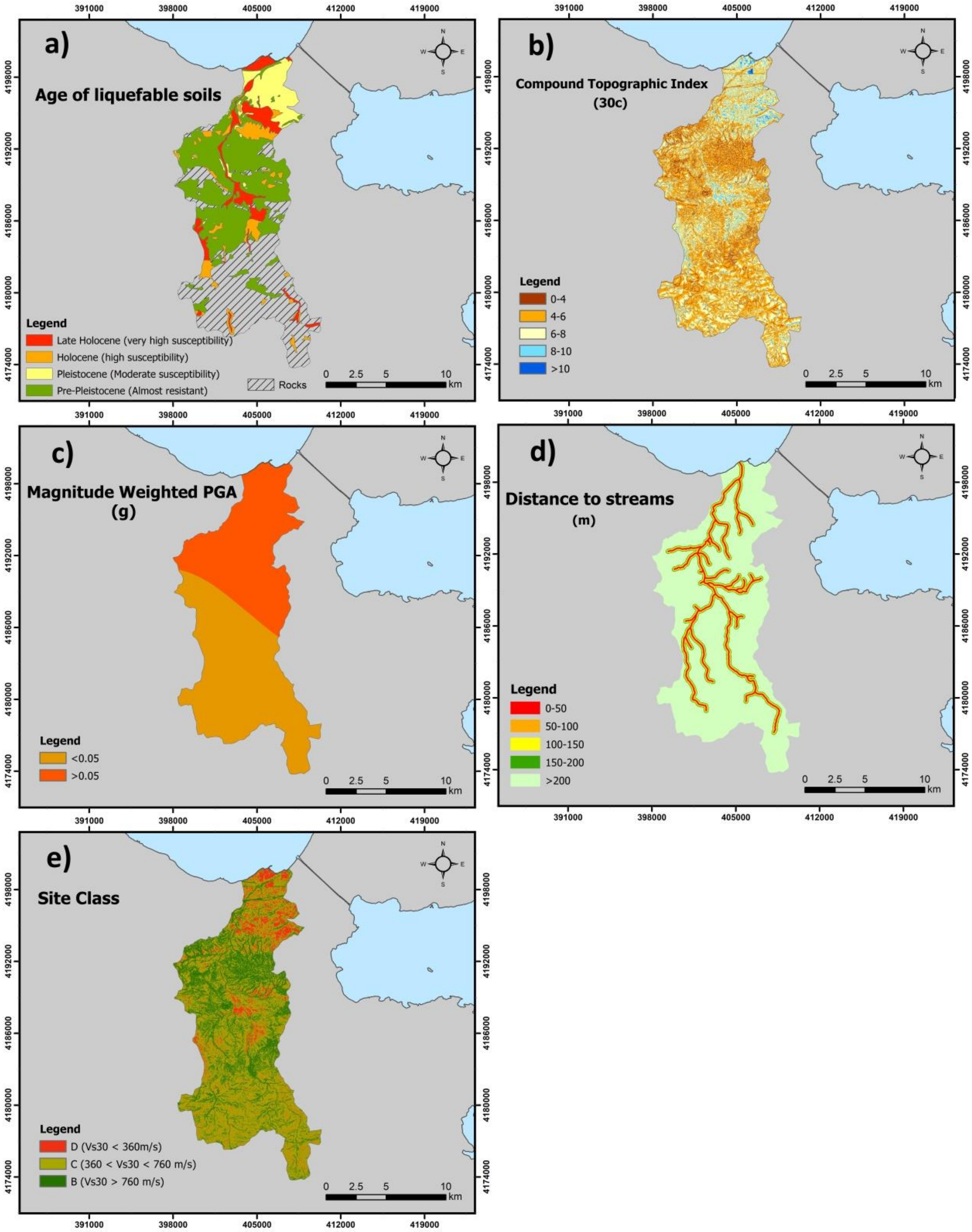

Figure 5. Thematic layers of the causative factors that contribute to the likelihood of soil liquefaction. a) Age of liquefable soils, b) compound topographic index, c) magnitude weighted PGA, d) distance to streams, and e) site class.

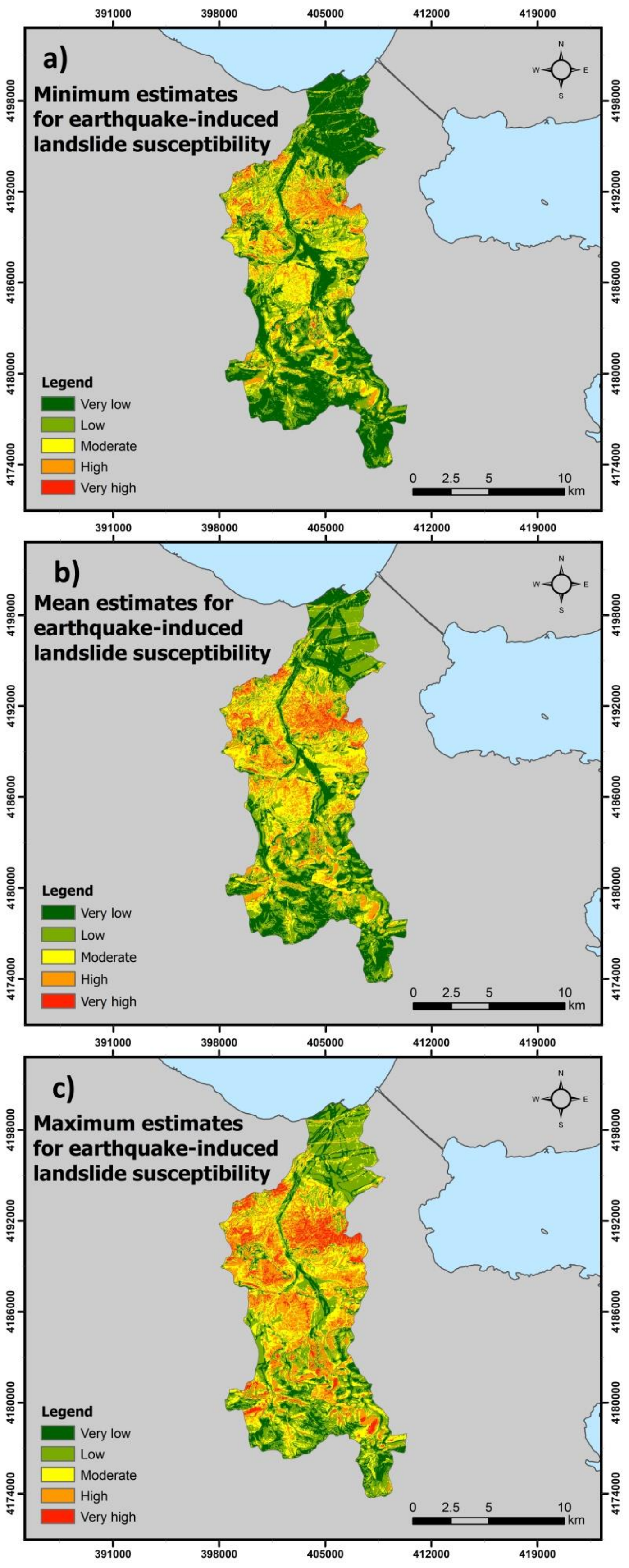

Figure 6. Earthquake-induced landslide hazard zonation map. a) Mean, b) minimum and c) maximum estimates.

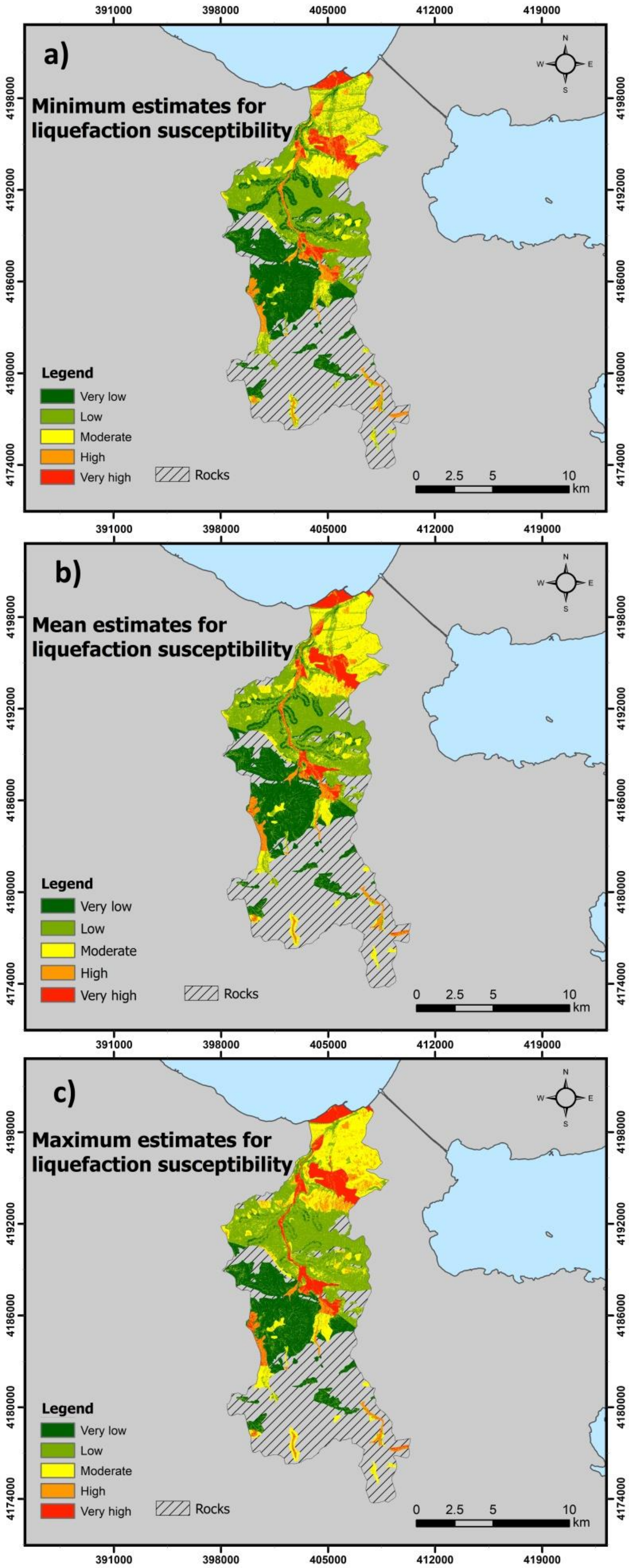

Figure 7. Liquefaction hazard zonation map. a) Minimum, b) Mean and c) Maximum estimates.

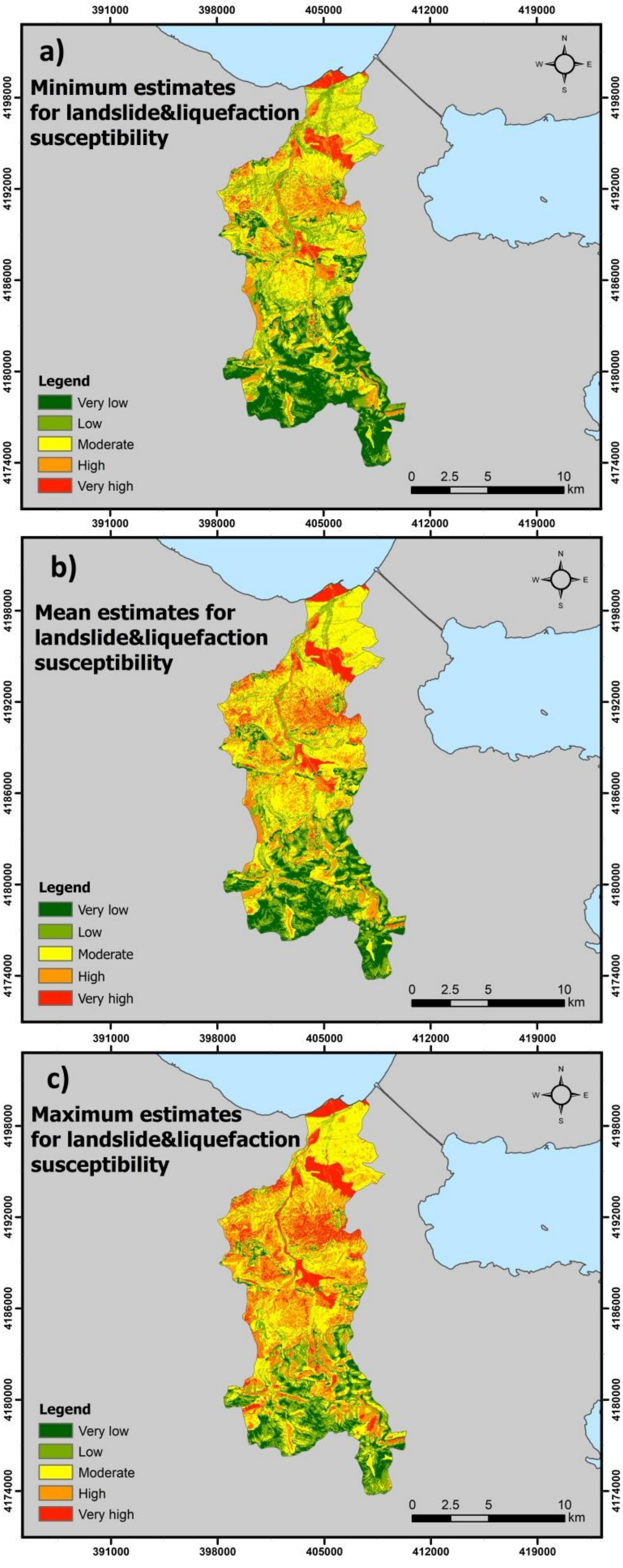

Figure 8. Hazard zonation map for earthquake-induced phenomena. a) Minimum, b) Mean and c) Maximum estimates.