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

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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 areas 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.

Initially, we evaluated separately the hazard from earthquakes, seismically-induced landslides and soil liquefaction. Subsequently we stacked them into one single hazard map reflecting a holistic seismic hazard assessment. Initially, we estimated a hazard map associated merely with the seismic potential of the study area. In this context, we used a pure statistical and a semi-statistical approach by means of the extreme values method and the Cornell approach and estimated the spatial distribution of the maximum expected values of Peak Ground Acceleration (PGA) as well as Moment Magnitude for a return period of 475 years. These two data layers were inserted into the AHP along with information about the geological formations and the active faults of the study area, to produce the earthquake hazard assessment map. The map was produced using Geographic Information System (GIS), by applying weights and drawing a hierarchical structure to the sub-criteria of the above thematic layers. Next, we evaluated separately the earthquake-

induced landslide hazard. For this purpose we incorporated into the AHP the parameters of the maximum expected values of Arias Intensity for a return period of 475 years, slope, lithology, aspect, distance to streams, distance to roads, landuse and topographic position index (tpi). Using GIS we produced a map depicting where earthquake-induced landslides are most likely to occur. Afterwards, we evaluated the soil liquefaction hazard adopting the same approach, using the parameters of compound topographic index (cti), type of soils, distance to streams and the magnitude weighted PGA. Finally, we stacked these three hazard maps and we classified the study area into four hazard levels corresponding to a complete seismic hazard map that accounts for earthquakes and for seismically-induced secondary effects.