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Applying Weight of Evidence method in landslide susceptibility assessments

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Landslides are the result of a number of natural processes that contribute decisively to the evolution of Earth's surface. It has been reported that due to the interaction of landslide phenomenon with the man kind activities they are considered as one of the most dangerous natural hazards, with serious repercussions on the economic and social development of an area, and also in some case the loss of human lives. According to Kjekstad and Highland (2008) landslides are the 7th more destructive natural hazard responsible for the 17% of deaths caused by natural disasters. According to Brabb (1985), 90% of the losses caused by a landslide could be avoided, if the landslide risk is recognized and evaluated prior to the occurrence of the incident. In this direction, in recent years, a systematic effort is being made towards mapping the areas which are prone to landslides by implementing various methods and techniques (Pourghasemi *et al*., 2018). A decisive impetus to this effort have been made by the implementation of Geographic Information Systems (GIS) along with the introduction of sophisticated methods, expert based, statistical, probabilistic or deterministic, that are capable to provide valuable information concerning the relation between landslides and geo-environmental variables (Hong *et al.*, 2017; Tien Bui *et al.*, 2017). In this context, the main purpose of the present study was to produce a landslide susceptibility map based on a probabilistic method, Weight of Evidence, within a GIS framework and also to perform a sensitivity analysis so as to identify the response of the model to small changes in the weights of the selected conditioning factors (Ilia and Tsangaratos, 2016). In order to evaluate the efficiency of the WofE model, Selinoundas river basin, located at Achaia County, Greece has been selected as an appropriate test site. ArcMap 10.1 software (ESRI, 2013) was used for accessing the data and for producing the landslide susceptibility map, whereas data and information obtained from bibliographic references and previous studies regarding the landslide activities in the region were the main source of data (Tsagas, 2011; Tsangaratos *et al.*, 2015; Polykertis and Chalkias, 2018).

In more details, the methodology which was followed during the present study included four stages of analysis. During the first stage a total of 37 landslide locations were used as training data and 9 landslide conditioning factors were selected, namely: elevation, slope, aspect, profile curvature, plan curvature, geology, topographic wetness index (TWI), distance from rivers and distance from faults. The second stage involved classifying each variable and weighting them according to the results obtained by the method Weight of Evidence. The third stage involved the construction of the landslide susceptibility map, whereas to evaluate the performance of the developed methodology the area under the success curve (AUC) was used. The fourth stage involved the implementation of a sensitivity analysis.

Based on the implementation of the WofE model concerning the conditioning factors, slope, profile curvature and elevation are shown to influence more the landslides spatial distribution, while geology is proved to be the most sensitive factor in changes according to the sensitivity analysis. The variable geology, shows the highest fluctuation concerning the relative landslide density that reaches the 7.05% within the zone of moderate susceptibility, 9.71% within the high susceptibility zone and 3.42% within the very high susceptibility zone. This could be attributed to the fact that the scale of the geological maps that were used as the primary source may not had been ideal for the purpose of analysis. Valuable information about the extent of each geological formation may be missing, however, the overall evaluation of the variable do not suggest removing it from the analysis. Figure 1 illustrates the landslide susceptibility map produced by the WofE model depicting the basin area in five susceptibility zones: very low, low, moderate, high and very high susceptibility. The performance of the model has been evaluated by estimating the AUC value which was estimated to be 0.78, indicating a satisfactory classifying ability.

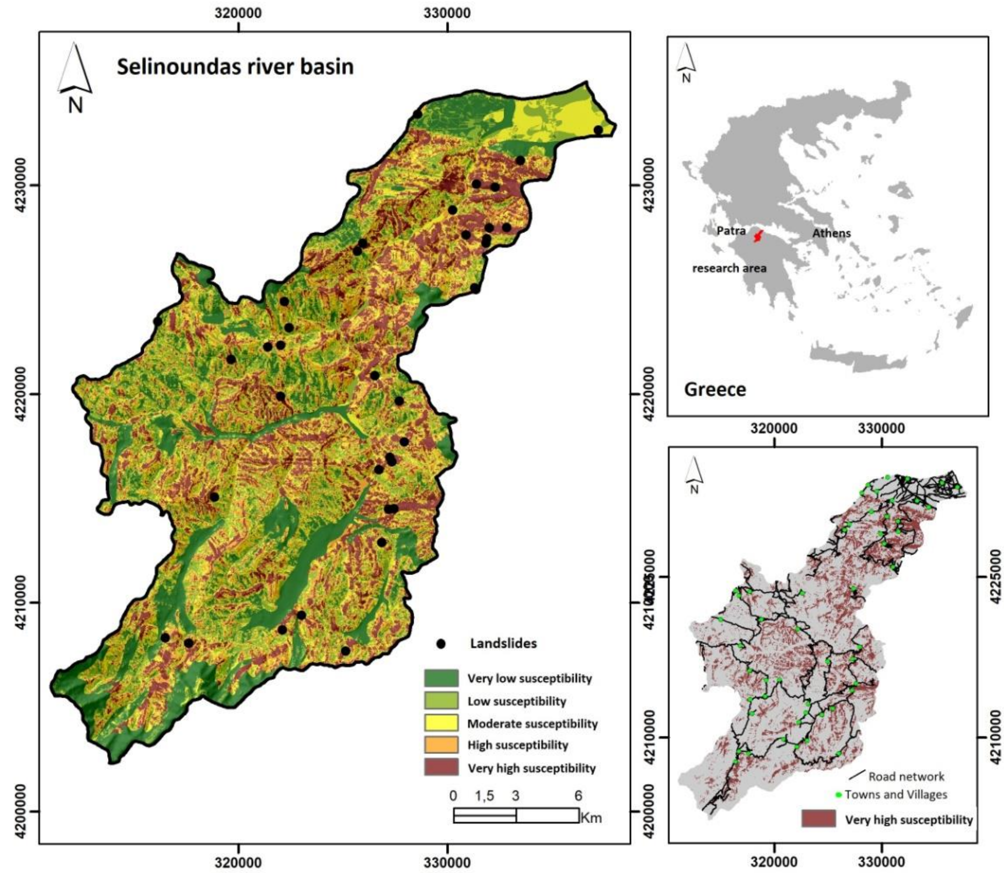

Figure 1. Landslide susceptibility based on WofE model.

According to the landslide susceptibility map, the main part of the basin area, including villages and parts of the road network, is classified in the zones of high and very high susceptibility indicating that there is an urgent need for prevention and protection measures to be taken. Furthermore, given the large area of the basin which is characterized by high and very high susceptibility as well as the high cost of constructing mitigation structures, the creation of a risk map based on the produced landslide susceptibility map is of first priority so as to implement targeted actions and appropriate prevention measures.

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