Landslide susceptibility and risk assessment: specificities for road networks

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A regional-scale assessment of landslide susceptibility and risk along the main road corridors crossing the provincial territory of Matera (Basilicata Region, Southern Italy) was carried out. The entire provincial road network extends for about 1,320 km through a territory, of which represents the main connection infrastructure among thirty-one municipalities due to the lack of an efficient integrated transportation system through the whole regional territory. For this reason, the strategic importance of these roads consists in their uniqueness in connecting every urban center with the socio-economic surrounding context. These roads and their vehicular traffic are continuously exposed to instability processes (about the 40% of the total length is disrupted by landslides), characterized both by high intensity and low frequency and by low intensity and high frequency. This last typology, consisting in small shallow landslides, is particularly hazardous for the roads since it is widespread along the road network, its occurrence is connected to rainfalls and determines high vulnerability conditions for the road in terms of interruption of vehicular traffic.

A GIS-based heuristic-bivariate statistical predictive model was performed to assess and map the landslide susceptibility in the study area, by using a polynomial function of eight predisposing factors, weighted according to their influence on the landslide phenomena, recognized and collected in an inventory. Susceptibility associated to small shallow phenomena was assessed by using a polynomial function of specific factors, such as slope angle and aspect, lithological outcrops, rainfalls, etc. In absence of detailed input data, the spatial distribution of landslide risk along the road corridors was assessed and mapped using a qualitative hazard-consequence matrix approach, by which risk is obtained by combining hazard categories with consequence classes pairwise in a two-dimensional table or matrix. Landslide hazard, which is a function of the return time, due to the lack of temporal data, was evaluated as a function of the landslide intensity (velocity and areal extent) and susceptibility.

The direct consequences of instability on the roads were defined by combining exposure and vulnerability in a matrix. Exposure was evaluated in terms of amount of traffic, which was calculated along each road stretch, connecting two or more urban areas, as a function of the average of population of each centers. Vulnerability, which expresses the degree of damage, was assessed in function of the presence of criticalities along roads, which were ranked according to the severity of damages and type of performed reparation works. The consequences, combined with the hazard levels, allowed to assess the landslide risk, classified in low, medium and high levels. The risk map highlighted that about the 30% (392 km) of the examined road corridors is affected by high risk levels. The comparison between the risk map and the landslide inventory recognized along roads has also revealed that the 49.5% of landslides affects sections where the risk was evaluated high. The obtained risk classification of the roads represents a support for decision making and allows to identify the priorities for designing appropriate landslide mitigation plans.