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Hazard maps of earthquake induced permanent displacements validated by site numerical simulation

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Hazard maps of seismically induced instability at the urban scale can be drawn by means of GIS spatial interpolation tools starting from (1) a Digital terrain model (DTM) and (2) geological and geotechnical hydro-mechanical site characterization. These maps are commonly related to a fixed return period of the natural phenomenon under study, or to a particular hazard scenario from the most significant past events. The maps could be used to guide the planning activity as well as the emergency actions, but the main limit of such maps is that typically no reliability analyses is performed. Spatial variability and uncertainties in subsoil properties, poor description of geomorphological evidence of active instability, and geometrical approximations and simplifications in DTMs, among the others, could be responsible for inaccurate maps. In this study, a possible method is proposed to control and increase the overall reliability of an hazard scenario map for earthquake-induced slope instability. The procedure can be summarized as follows: (1) GIS Statistical tools are used to improve the spatial distribution of the hydro-mechanical properties of the surface lithologies; (2) Hazard maps are drawn from the preceding information layer on both groundwater and mechanical properties of surficial deposits combined with seismic parameters propagated by means of Ground Motion Propagation Equations; (3) Point numerical stability analyses carried out by means of the Finite Element Method (e.g. Geostudio 2004) are performed to anchor hazard maps prediction to point quantitative analyses. These numerical analyses are used to generate a conversion scale from urban to point estimates in terms of permanent displacements. Although this conversion scale differs from case to case, it could be suggested as a general method to convert the results of large scale map analyses to site hazard assessment. In this study, the procedure is applied to the urban area of Castelfranci (Avellino province) located in the central sector of the Italian Apennine Chain. The village is set in an unstable territory where strong earthquake events like the 1980 Irpinia earthquake occur. Lithological, hydrogeological, and geotechnical maps have been used, combined to landslide inventory maps, to draw hazard scenario maps related to a seismic event as strong as the 1980 Irpinia earthquake (ML=6.1). The proposed procedure enables to test the hazard maps at all those sites where litho-type mechanical characterization is available, and to generate a conversion scale for permanent displacements predicted by both GIS tools and numerical analyses.

References

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