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Influence of structural heterogeneities and of large scale topography on imbricate gravitational rock slope failures: New insights from 3-D physical modeling and geomorphological analysis.

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Gravitational rockslope failure generally results from the interplay of several factors, among which topography and structural heterogeneities are known to play a dominant role. The influence of initial topography on fractures activation and on gravitational failure processes are however still misunderstood. To address this question we performed scaled 3-D physical models based upon the well documented landslide at Randa (Switzerland). Previous 2-D physical modeling results demonstrated that even if few preexisting fractures are activated / propagated during gravitational failure all of those heterogeneities had a great influence on mobilized volume and it's kinematic. The question we address in the present study is to determine if such a result is also observed in 3-D. The 3-D models consisted of a homogeneous material in which several fracture zones were introduced in order to study simplified but realistic configurations of discontinuities. Results showed that the type of gravitational failure (deep-seated landslide or sequential failure) and resulting slope morphology evolution are the result of the interplay of initial topography and inherited pre existing fractures (orientation and density). The three main results are i) the initial topography exerts a strong control on gravitational slope failure. Indeed in each tested configuration (even in the homogeneous one) the Grossgufer area is affected by a rock slide, ii) The amount of fracture sets greatly influences the mobilized volume and it kinematic, iii) The zone involved in the 1991 is smaller than the results produced by the analogue modeling. This indicates that the mobilized zone in 1991 is probably only a part of a larger deep-seated landslide and/or larger deep seated gravitational slope deformation. This last result is confirmed by geomorphologic analysis. Indeed, the characterization of the available volume that can be affected by rockslide has been obtained using the sloping local base level (SLBL) concept. The latter is obtained by creating an artificial stream network using standard GIS functions, and creating a surface linking the streams by a surface created by linear interpolation between the streams. Results show clearly that the spur of Randa rockslide possess the larger excess of available material in the area. In addition, the available volume extends a lot above the 1991 scar. Recent data indicate however that the top of the spur is not moving. This may indicate that mobilized volume containing the 1991 scar: i) is dormant or ii) will develop during the next stage of the slope evolution or iii) the slope was been affected by landsliding before last glacial maximum. The latter could be supported by the fact that the present topography is rounded as relief that is slightly eroded by glacier.