Estimating Landslide Volumes Using the LS-Rapid Model - The 2000 Stože Landslide Case in NW Slovenia -

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INTRODUCTION

After intense rainfalls, the Stože landslide in NW Slovenia was triggered in November 2000. After the initial debris landslide on November 15, the second wet debris flow on November 17 partly destroyed the village of Log pod Mangartom and claimed 7 casualties. Several post-event studies were carried out (e.g. Četina et al., 2006; Mikoš, 2011; Maček et al., 2017). In this study, the LS-Rapid model (Sassa et al., 2010) was applied to trigger the Stože landslide and to gain "know how" when estimating landslide hazard elsewhere in Slovenia.

MATERIAL AND METHODS

The LS-Rapid model was applied using available topographic data of the Stože slope and a geological map (scale 1:100,000). For defining pre-event topography of the slope, we combined recent LiDAR based DTM (1x1m resolution) and the old topographic maps. Soil parameters were defined for every geological unit using additionally developed tools. A triggering model was prepared and a sensitivity analysis was carried out for model parameters τ_{ss} and r_u, since r_u was the only triggering factor in the model, while τ_{ss} governs the spreading phase of the first instability in the model and the landslide moving phase. After the sensitivity analysis, a final model was prepared and the 2000 Stože landslide simulated.

RESULTS

The modeling results show good agreement with the November 15, 2000 event. Comparison of modeling results and field survey after the event show good spatial matching of the landslide area (**Fig. 1**), area of the first instability, landslide volume (measured: 1.2 mio m^3 (Četina et al., 2006), simulated: 1.29 mio m^3) and also the landslide run-out in the Mangartski potok channel. Key parameters of the final simulation model are as follows:

Gravel: $\phi i = 40°$; $\phi_m = 40°$; τ_{ss} =190 kPa; $B_{ss} = 1.0$; $\phi_p = 42°$ $c_p = 5.0$ kPa; $\gamma = 22$ kN/m^3

Moraine: $\phi i = 36°$; $\phi_m = 36°$; τ_{ss} =190 kPa; $B_{ss} = 1.0$; $\phi_p = 37°$, $c_p = 25.0$ kPa; $\gamma = 23$ kN/m^3

Other parameters: DL = 1mm, DU = 1000mm and $r_u = 0.3$ (constant value)

DISCUSSION

Modeling results show that the LS-Rapid model can be applied for estimating landslide volumes. Since once triggered landslides can turn into debris flows, determination of potential landslide volumes in torrential watershed is an important input data for estimating potential debris-flow magnitudes. Since all parameters of the LS-Rapid model cannot be measured or reliably defined, we suggested methods for τ_{ss} and r_u estimation when simulating triggering of potential landslides.

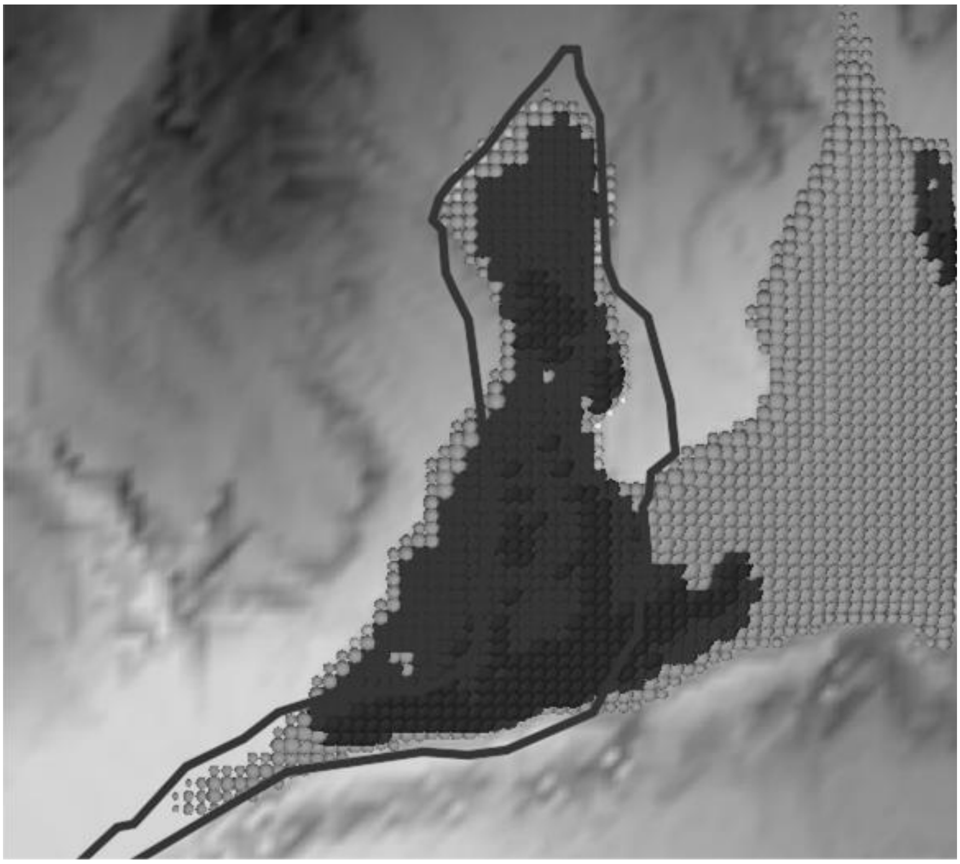

Fig. 1 Final modeling result after 100 s with the surveyed contour of the 2000 Stože landslide

CONCLUSIONS

The LS-Rapid model turned out to be a useful tool for assessing potential landslide volumes in torrential watersheds. Its application has some model-based limitations and require experiences in soil mechanics for defining all required model input parameters. Realistic volume estimations of potential landslides can present an important improvement in the debris-flow hazard assessment in those torrential watersheds that have been recognized as debris-flow prone.

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