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Elucidating the role of soil hydraulic properties on the aspect-dependent landslide initiation

Detailed Response to the Reviewer Comments

Thank you, Tammo Steenhuis.

Thanks for your constructive comments, helping to improve the quality of our manuscript. We are sorry for delaying answer the valuable comments because we are asked to stay at home for almost 2 months, due to the Coronavirus policy in Beijing and Beijing Forestry University. In such a condition, the team members read the comments and revised carefully after we are permitted to enter the office. With full consideration of the reviewers' suggestions, the manuscript has been carefully reshaped and we made point-by-point responses to address the comments of the reviewers. In the following, we answer all comments (set in black fonts) and give response (set in blue fonts). Quotes of the revision are set using a red font.

Reviewer #2:

The authors present a complicated explanation for the greater number of bank failures on the south slope than on the north slope.

Response: Thanks for the appreciative comments.

I am not sure if the analysis is correct since hillslope stability is not my field. However, I know that when the soil becomes saturated, the hillslope could fail, given that roots do not keep it in place. Based on this simple principle, we can explain, based on the data given in this manuscript, the difference between the north and south-facing slopes in simple terms as follows:

1. The conductivity of the subsoil is greater on the north-facing slope than on the south-facing slope. Thus, the north-facing slope drained faster than the south-facing slope, and as shown in Figure 9, the soil on the north-facing slope does not saturate. In contrast, on the south-facing slope, the rainfall rate at some point is greater than the water that can be carried off laterally, and the soil saturates, as shown in figure

9. The saturation causes the soil strength to decrease, and failure occurs. Hence more failures on the south slope than on the north-facing slope.

Response: Thanks for your detailed comments.

The drainage ability of hillslope materials is merely one of the factors. In the study area, the aspect-dependent landslide initiation may result mainly from the hydraulic conductivity, which indirectly attribute to the difference weathering. However, shallow landslides result from multiple factors, including the strength of hillslope materials, hydraulic conductivity, slope profile, and topographic factors. As the hydraulic conductivity plays a more important role on the landslide distribution, we mainly examined its role on the landslide initiation. However, the stability analysis results of the two models combines multiple factors, including the suction stress, cohesion, friction, topographic slope, failure depth. Importantly, the excessive pore water pressure dissipation strongly proves the drainage ability of hillslope materials. Therefore, excessive pore water pressure, together with the stability analysis greatly improve the understanding and elucidation of the reason about aspect-dependent landslide initiation.

2. Figure 9 is hardly discussed in the manuscript. It is likely the most significant finding as it shows that the oil becomes saturated on the south slope while not on the north slope.

Response: Thanks for your valuable comments.

First, thanks for your important reminds here and we may neglect your finding because we mainly focus on the water storage and leakage process based on the observed soil moisture. Secondly, figure 9 merely shows the volumetric water content during the observation stage, and mainly supports the results of figure. 10. In the revised manuscript, we added new contents according to your suggestions:

In comparison, it is likely the most significant finding as it shows that the soil becomes nearly saturated on the south slope while not on the north slope. This implies that the soil water on the south-facing slope is difficult to drain because of more fine

grains and the slow pore water pressure dissipation. Besides, the stable soil moisture of layers No. 2 and 3 for both slopes may attribute to long dry seasons in the study area, and the daily rainfall amount > 30 mm on July 9 and 23 resulted in soil moisture increase for all slope layers.

3. On line 377, the authors write that "the saturated hydraulic conductivities by variable-head permeameter and TRIM methods coincide with each other, which together prove that the soil mass on north-facing slope has a relatively larger water infiltration. The amount of water infiltrated on a slope depends on the amount of rainfall and not the conductivity as long as it is greater than the rainfall rate. Moreover, laboratory-derived conductivity is a poor predictor for field hydraulic conductivity in the topsoil where plant roots and animal life provide vertical preferential flow paths.

Response: Thanks for your detailed comments.

Your comments here highlighted the importance of in-situ measurements on the hydraulic conductivity. We also want to carry out the field hydraulic conductivity test, which would be more reliable than the laboratory-derived conductivity. However, it is very dangerous to carry out field tests because there were no human beings there after the extreme events in 2013. However, the Test of TRIM method were carried out in the laboratory. Besides, it is time-consuming to carry out in-situ measurements because the tests of preferential flow path must consider multiple sites. Therefore, we choose to monitoring the soil moisture to check the soil water storage and leakage. Additionally, you can see from figure 9 that the preferential flows are in form of sequential flow, not the nonsequential flow. In future, if possible, we may continue to examine the preferential flow path and analysis the effect on the landslide initiation.

4. As I indicated before, I leave it up to the experts if the hillslope analysis is correct or not. It seems too complicated for the little information that is available on this site. The fact that the soil strength decreases greatly at the time the soil becomes saturated is important and is not well addressed. In addition, the fact that soil saturates should be stressed in the manuscript that claims to be a hydrologic analysis.

Response: Thanks for your valuable comments.

There is no doubt that the hillslope stability analysis is correct in this work. On basis of suction stress definition in the Soil mechanics for unsaturated soils, the soil strength is from two parts: the first part derives from the particle connection, and the second part comes from the capillary force depending on the soil moisture. If the soil becomes nearly saturated, the soil strength will reduce greatly because the matrix suction disappears. The reason why we choose two stability models to analyze the hillslope stability fluctuation lie in that the role of hydrologic properties on the aspect-dependent landslide initiation is more important than other factors. Therefore, some hydraulic properties, such as the hillslope material properties, unsaturated conductivity, excessive pore water pressure, soil water storage and leakage, must the clarified in advance to support the stability analysis.