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Discussions

Interactive comment on "Evaluating the Efficiency of Subsurface Drainages for Li-Shan Landslide in Taiwan" *by* Der-Guey Lin et al.

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General Comments: An interesting case study that highlights the role of drainage systems to reduce pressure heads within a landslide area is presented in the paper. The manuscript is clear and the scientific quality is generally good, although some parts lose strictness and need to be strengthened and improved. The structure of the paper can be improved, since a literature review on the specific topic (stabilization of large landslides with deep drainage interventions) lacks in the current version of the manuscript and must be added. Probably, the initial part of the manuscript (that is the general description of the landslide and the drainage works; sections 1 and 2) is too detailed and can be shortened, thus leaving space to the state-of-the-art discussion. In some parts the text is prolix, while the authors should better highlight the specific contribution of their scientific work. Response: (1) The literature review on stabilization

of large landslides with deep drainage interventions has been added. Please see the introduction of the revised manuscript. (2) The initial part of the manuscript that is the general description of the landslide and the drainage works (sections 1 and 2) has been shortened and the state-of-the-art has been added and discussed. (3) The specific contribution of the scientific work has also been highlighted. Specific comments: A specific section on the subsurface hydraulics of the slope before intervention (from where the authors have started in their study) is needed, so that pre-intervention field measurements, monitoring stations, soil hydraulic parameters, along with the results of pre-intervention seepage analyses should be reported in detail. This part could be really helpful to clarify the role of drainage in the slope hydraulics. Response: The subsurface hydraulics of the slope before intervention (pre-intervention) of subsurface drainage was illustrated in the following figures and the results were also compared immediately with those of post-intervention. (1) Monitoring stations: Fig. 11 (monitoring stations B4 and B5). (2) Pre-intervention field measurements: Fig. 14 (a) B5 observation and Fig. 15 B5 monitoring station (3) Soil hydraulic parameters: Table 1 (4) Pre-intervention seepage analyses: Fig. 14 (a) B5 simulation of groundwater level variation; Fig. 17(a) pore water pressure of First potential sliding surface (1st-PPS); Fig. 20(a) groundwater levels variation; Fig. 22(a) B4 simulation of volumetric water content. The authors should better clarify the choice of assigning in their seepage analysis a "free seepage surface boundary condition" to the horizontal drainages, instead of a zero pressure head boundary condition. The current explanation of the choice is unclear. Response: (1) The horizontal drainage assigned by a "free seepage surface boundary condition" in numerical simulation is verified to be proper through a series of numerical experiments. (2) If the horizontal drainage is assigned by a "zero pressure head boundary condition with zero pressure head hp=0", some unrealistic numerical results may occur. During the seepage analysis, if a portion of horizontal drainage with zero pressure head boundary condition (pressure head hp=0) situates above the groundwater level at unsaturated zone (negative pressure head, hp<0) (or the groundwater level is lower than the horizontal drainage), eventually the horizontal drainage at unsaturated zone will numerically extract groundwater flow from saturated zone (positive pressure head, hpïĂ¿0) and this is unrealistic in engineering practice. Above explanations have been added in the relevant paragraph (Section 3.2) of the revised manuscript. How were the soil strength parameters reported in Table 2 chosen? This point requires a discussion from the authors. Response: Large quantities of field tests and laboratory tests (direct shear tests) were carried out to determine the soil strength parameters during the implementation of the subsurface drainage project. Average value of parameters was used for numerical analyses. Above discussion has been added in the relevant paragraph (Section 3.2) of the revised manuscript. Vertical scale in Figure 15 is not adequate. The authors should enlarge the scale of y-axis, so that the trend can be better appreciated. In particular, it seems that in Fig. 15a the simulation is not capable of catching the effect of cumulated rainfall, as observed in reality. Response: (1) The scale of y-axix of Figure 14 (Figure 15ïĆőFigure 14) has been enlarged. (2) As shown in Fig. 14, the maximum deviation of the simulation from the observation of B5 groundwater level without and with subsurface drainage is about 0.5 m and 0.2 m respectively. These deviations are most likely caused by the simplification of 2-D numerical model which unable to capture the effect of 3-D hydrological/geological structure of soil strata. Above comments have been given in the relevant paragraph (Section 4.1) of the revised manuscript. Table 4: it is unclear why Fs values increase during the rainfall history. This is not possible, since the effect of drainage should be a lower reduction of Fs respect to the pre-intervention situation, but not an increment. Fs could eventually increases in the long-term due to the effect of drainage, but not during a rainfall event. A comment from the authors on this point is required. Also, vertical scale in Fig. 20 should be enlarged to appreciate the trends. Response: (1) The scale of y-axix of Fig. 19 (and Fig. 18) has been enlarged (Fig. 20ïĆőFig. 19 and Fig. 19ïĆőFig. 18). (2) Numerically, the calculations of Fs value and groundwater level are largely dependent on the rainfall history (infiltration boundary condition of ground surface) and the subsurface drainage (free seepage surface boundary condition of horizontal drains). (3) In Table 4, the increase of Fs values

(at rainfall duration t=377 hr) is mainly caused by imposing a fictitious subsurface drainage remediation on the numerical model during Amber Typhoon. As shown in Fig. 19, even though in the time duration without precipitation (t=120 hr 340 hr), the fictitious drainage remains functioning and lowering the groundwater level (also increases the Fs value) numerically. Related to the previous point, it is unclear why groundwater level in Fig. 21 lowers as respect to the initial groundwater level during a rainfall history. Response: Similar to the explanations in the previous point (Fig. 19), the initial groundwater level is lowered down in Fig. 20 (Fig. 21ïĆőFig. 20) due to the fact that the function of fictitious drainage imposed on the numerical model in the time duration without precipitation (t=0 23 hr) as shown in Fig. 19. Some comments and explanations have been given simultaneously for the Fs value and groundwater level in Table 4, Fig. 19 and Fig. 20. Technical comment: - section 3 is completely repeated in section 4. Please remove section 3. Response: The instruction is followed.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2015-309/nhess-2015-309-AC3-supplement.pdf

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