Specific comment

#1 and #3

The first equation on page 11047 should in my opinion be: $N_{fis} = F_{fis} \cdot \frac{\Delta x \cdot \Delta y}{a_{fis} \cdot l_{fis}}$ **with l_{fis} an average length of the fissures.**

I do not immediately see how the authors got to Equation 3, but it seems wrong to me too: in case of only one fissure the result would be 1 $\overline{\tfrac{1}{2} L_{mat}} = L_{mat}$

$\overline{\tfrac{1}{2} L_{mat}}$ is only a notation. We agree that it can be misleading that is why we changed it to $\overline{L_{mat-fis}}$

The Reviewer is right that presented equations 1-3 are not harmonized with the description of the fissure presented in the paper.
The equations in the form presented in the paper were used in the older version of our code where the F_{fis} was defined in different way. By carelessness, it remains unchanged in one place in the new version of the code - when calculating the number of fissure. This then influenced the calculation of gradients for fissure – matrix interaction within the soil column and transitivity of groundwater flux between the cells. In all other calculation (e.g: storage capacity, partitioning of the precipitation, percolation, etc) the term F_{fis} was correctly applied.

The correct equation are:

Equation 1: (please not that we have fissure in both directions (x and y) within one cell)

$$N_{fis,x} = N_{fis,y} = (1 - \sqrt{1 - F_{fis}})\frac{\Delta x}{a_{fis}}$$

where $N_{fis,x}$ is the number of fissure in x directions.

Equation 2:

$$L_{mat} = \sqrt{1 - F_{fis}} \frac{\Delta x}{N_{fis,x} + 1}$$

And Equation 3

$$\overline{L_{mat-fis}} = \frac{1}{2}(L_{mat} + a_{fis})$$

We performed additional model runs with corrected equations. The influence of our mistake has relatively limited impact on overall model outcomes. The absolute values are changed but the trends and overall conclusions remain the same. We will correct the calculation result and adapt the description.

#2

- I do not see why the N_{fis} needs a minimum value of 1, why can decimals not be allowed?

The volume of fissures within one cell is defined by the fraction of surface area covered with fissures (F_{fis}) and the mean fissure aperture (a_{fis}). It is assumed that the number of fissure per cell ($N_{fis,x}= N_{fis,y}$) is whole number. Therefore, when F_{fis} is >0 and a_{fis} >0 it is set to be equal minimum value of 1.

#4 & #5

I think the direction of the cracks should in some way be included as a crack parallel to the slope direction would have a very strong drainage function while a crack perpendicular to the slope direction would have a strong destabilizing on the soil. I can imagine that the fissures in a landslide do have a dominant direction, but I might be wrong here.

The fissure connectivity part of the paper is confusing: shortly after the equation on page 11050 the authors mention the indirect connectivity via the matrix (i.e. no macropore connectivity). They also state on P 11048 that there is no explicit fissure to fissure groundwater flow. What is it?

These two comments are related to misunderstanding of what the model represents and how it is implemented. We see this as an omission from our side. Therefore we take double care to clarify this here and we will include this in the revised manuscript.

Fissures are distributed evenly through out the cell (in both x and y direction) and they extend vertically over the full depth of the layer. The distribution of fissures in two directions is included to approximate landslide reality (transversal and lateral fissures resulting form stress patterns and differential movements).

Lateral flow between the columns (Q_{sat}) occurs across the saturated zone only as result of differences in total piezometric head in the x- and y- direction. The total head in each column is composed of the gravitational potential, the elevation of the bottom of the soil column, and the average of the water level in the fissure network and the matrix, weighed by the respective surface area.

The total saturated lateral flux is subsequently distributed over the matrix and fissure domains on basis of the ratio of the transmissivity values within a column and the connectivity between fissures. Transmissivity per domain is the product of saturated permeability (fissure/matrix), water height (in matrix and fissure) and width (matrix width in cell and fissure width in cell).

Therefore, that there is no explicit "fissure to fissure" in adjacent column exchange of groundwater. The groundwater flow is solved independently of the fissure geometry, but it is redistributed according to fissure geometry. It is conceptualised in the fissure connectivity.

The fissure connectivity should be seen as a chance for the fissure network to be connected laterally between two soil columns. Basically, this means that the fissure fraction multiplied with the fissure connectivity is redistributed in the fissure system, the remaining part (1-C_{fis}) is flowing into the matrix domain.

Here we elaborate on the dynamic nature of the "fissure connectivity". We have made the "fissure connectivity" term (C_{fis}) dependent on the soil moisture content of the soil column. In this way we conceptualize the water exchange between columns (the total saturated lateral flux) as such that the effectiveness of the water flux between soil columns mimicking the flow through the fissure fraction depends on the saturation degree of the soil column. We established a relationship between soil moisture content in the soil column and "fissure connectivity". The threshold relationship is defined for field capacity to complete saturation: the chance for fissures to be connected is minimal (set as 0.10) if the overall saturation is relatively low (soil moisture content in column below field capacity) and maximum (set as 0.9) in case of full saturation. This dynamic fissure behaviour is thus a saturation dependent functional connectivity introduced into the spatially distributed hydrological model of STARWARS.

#6

a) From the results in figure 5 it looks as though connected fissures are connected in downslope direction and do manage to increase water transport to the toe of the landslide but do not drain it, this seems strange to me.

Connected fissures act as a natural lateral drainage network that allow for faster lateral flow of water. This is what we observe in the results of "connected fissure" scenario: the majority of the infiltrated water is accumulated in the lower part of the landslide while the upper part of the landslide is relatively dry.
However, the results of the 'connected fissures' scenario are also clearly affected by pre-defined bedrock topography (no-flow boundary) and converging water flow paths. The outflow from the landslide area is only possible in form of surface runoff at the toe of the landslide. Therefore, faster drainage through the connected fissure network propagates water relatively rapidly downward and downslope with converging flow paths resulting in an accumulation of water in the lower part of the landslide. The saturation of matrix is then the result of fissure matrix exchange ($\Gamma_{Unsat,\ FM}$,).

b) Also it seems that on the whole the landslide is wetter in the case of connected macropores. Does a large part of the water leave the simulated area as surface runoff in the other scenarios?

The water storage of the whole landslide is the lowest in case of the "connected fissures" and the highest in case of "disconnected fissures" scenario (Figure 4). It is also seen in Figure 7 and 8 that in case of "connected fissure" scenario observed groundwater level is almost always lower than the one observed with "disconnected fissure" and "dynamic connectivity" scenario. The only exception is the toe of the landslide (Figure 8 e). The later one is the effect of pre-defined bedrock topography (no-flow boundary) and converging water flow paths. See also answer 6a.

c) I would also expect that the macropores transport water to depth rapidly and destabilize the landslide from underneath, while without macropores the water has to infiltrate and percolate from the topsoil downwards. Therefore information on soil moisture content of the three different layers depending on the macroporosity scenario would be interesting.

The results presented in the paper shows clear effect of “connected fissure” scenario: increase rate of natural soil drainage, which limits the building up of water pressure and effect of the lowest percentage of unstable area (Figure 6). The effect of “disconnected fissure” is also clear: they maintain high pore water pressure.
The presence of fissure (both connected and disconnected) may also increase the rate of vertical infiltration providing direct access to the lower groundwater and increasing the rate of groundwater recharge. This behavior can be observed in Figure 8 – the groundwater level response for the rainfall events is faster in case of scenarios with introduced fissures network than in case of “no fissure” scenario.

 # 7
Technical corrections:

We will carefully address all the technical questions of the Reviewer.
The revised manuscript will be proof read by a native English speaker.