Questions and comments of the reviewer 3 are in bold

Your answer sounds quite promising and I am curious about reading the revision. If you would extent your story according to the listed points, I see potential for an improvement of your manuscript.

Thank you for the comment.

However, I still not really see the connection of the tracer test and modelling. I agree that a quantitative coupling (e.g. comparison of simulated and observed concentrations) will be very challenging caused by parameter heterogeneities, which are difficult to capture. Also, I can somehow agree to the argument that you want to provide a general modelling framework. However, this leaves me with the question: Why you Discussion paper incorporate the tracer test at all? How does it support your synthetic model? Besides showing natural heterogeneities, you just prove that a L-drain constitutes a preferential flow path. Isn't that a bit too trivial?

In our experience it never hurts to have field experiments backing up a modelling approach—actually quite the opposite. Even if it might appear trivial at a first glance we believe there is always value in the field data. Apart from this general consideration, we don't think it is a trivial as mentioned by the reviewer. Below some examples (which we will elaborate in the revised manuscript):

- It is also not all clear how important the natural heterogeneities and preferential pathways are in comparison with the drain.
- The price differences of these engineering structures are significant. Given that the models always need to simplify a system it is in our experience unwise to base decision purely on modelling approaches--- the most convincing approach is a combination of both with a demonstration that the planned systems work as planned, and then the models can help to identify how the proposed system will affect flow under different conditions.
- It could also be that the engineering structure is not well implemented or has not been communicated correctly. This is in fact a very common problem. It is not at all trivial to implement these engineering structures in wetland, as the construction machines cannot leave the road, access is difficult and there are legal considerations ect. With the field test we show that these structures can be built and functions as planned.

We want to highlight that this paper is directed not only towards the scientific community, but also stakeholder and the engineering firms who implement these structures. It it therefore particularly important to demonstrate that model can reproduce the general behaviour observed in the field.

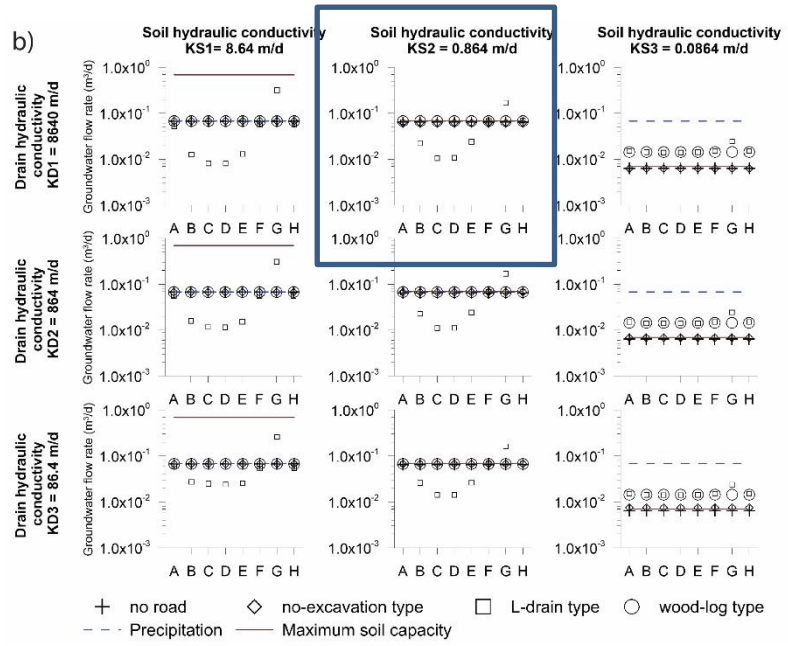
Finally, it is clear that below the road and immediately downgradient, the L-structure create a preferential flow path. However, the key question is how quickly flow redistributes again laterally further downgradient. With the suggested modifications (described in the next section), this question can be answered.

Moreover, regarding the term novelty, we seem to have a slightly different opinion. For me novelty should be more than the application of an existing model to just a new case. Sure, not all HESS papers present an entirely new model or method, but they should present at least a creative solution or new combination of methods. I encourage you to strongly revise your manuscript by adding some new ideas regarding e.g. drying up of fens or gully erosion (could be also something else). Basically, you should dig a bit deeper, but I am optimistic that you are able to do it.

In term of novelty we added a range of points as suggested by the reviewer. We agree that more results can be extracted from the modelling approach. It is the first time this topic is treated, and we also want to highlight that physically based models such as the ones we use are not that commonly used. Finally, we want to highlight that HESS also encourages the submission of applied research, as highlighted in the description of the journal:

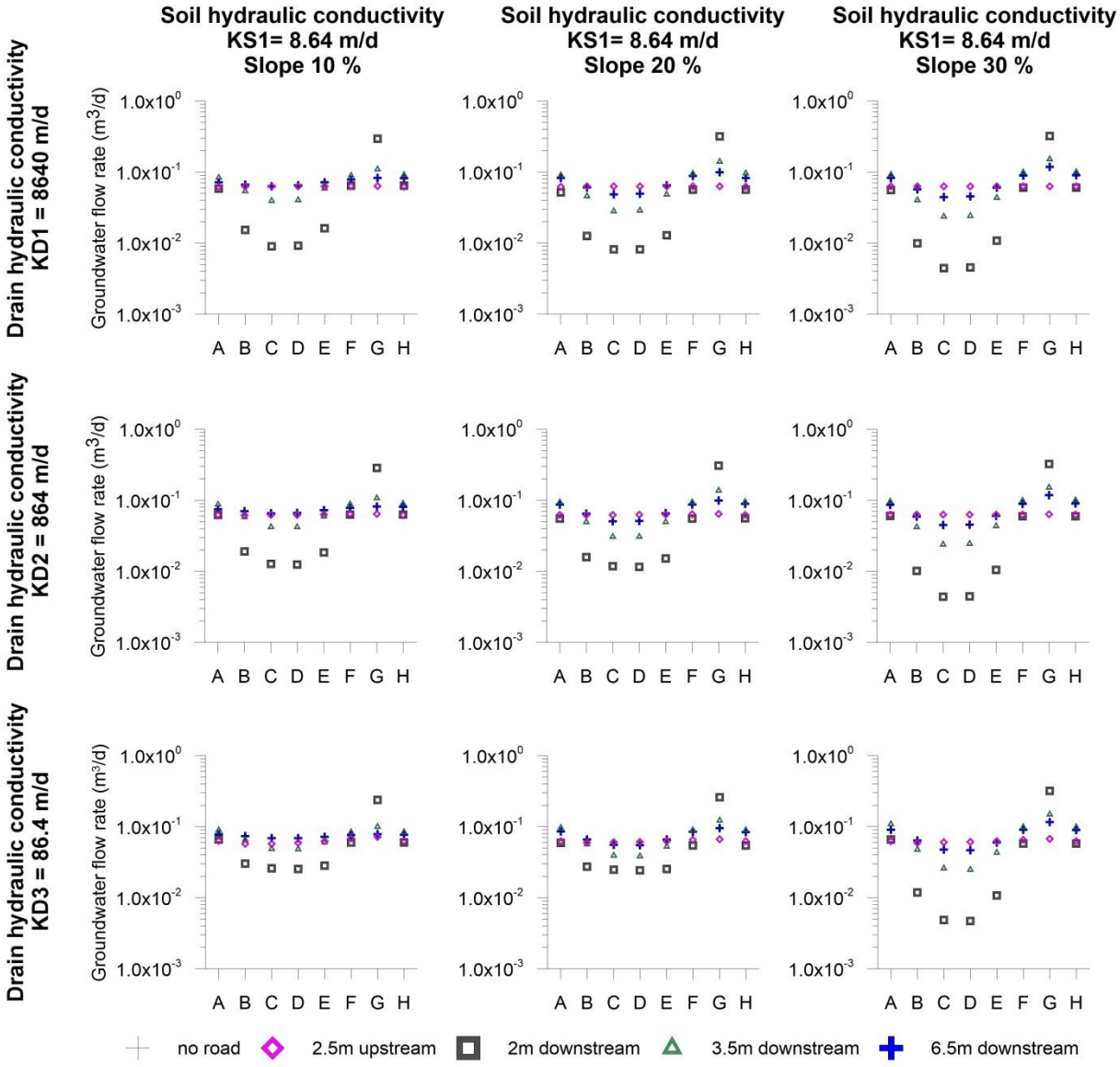
"*HESS encourages and supports fundamental and applied research that advances the understanding of hydrological systems, their role in providing water for ecosystems and society, and the role of the water cycle in the functioning of the Earth system.* "

In addition, section 3 will be reworked and new subsection will be added in which we assess the potential risk of gully erosion. To achieve this, the simulated groundwater flow rate will be compared with the maximum flux than can flow in the soil calculated with the Darcy law. If the road structure induces a groundwater flow higher than the soil capacity then gully may occur. For example in the surrounded plot in Figure below, you see that L-drain induces a groundwater flow rate higher than the soil capacity and therefore may induce gully erosion.



Simulated groundwater velocities 2 m downstream each road structures and each parameter combination with a slope 20%.

Finally, the simulation results will at different distance of the road to have a better assessment of the road impact. We will be also able to identify areas in which the soil layer is not fully saturated or on the contrary areas in which runoff occurs. See an example in the figure below.



Extent of perturbations due to the l-drain road type: Simulated groundwater flow rates at different distances of the road.

Minor comments

General: Sometimes you are using spaces between numbers and operators and sometimes not. Please, check the guidelines of the journal.

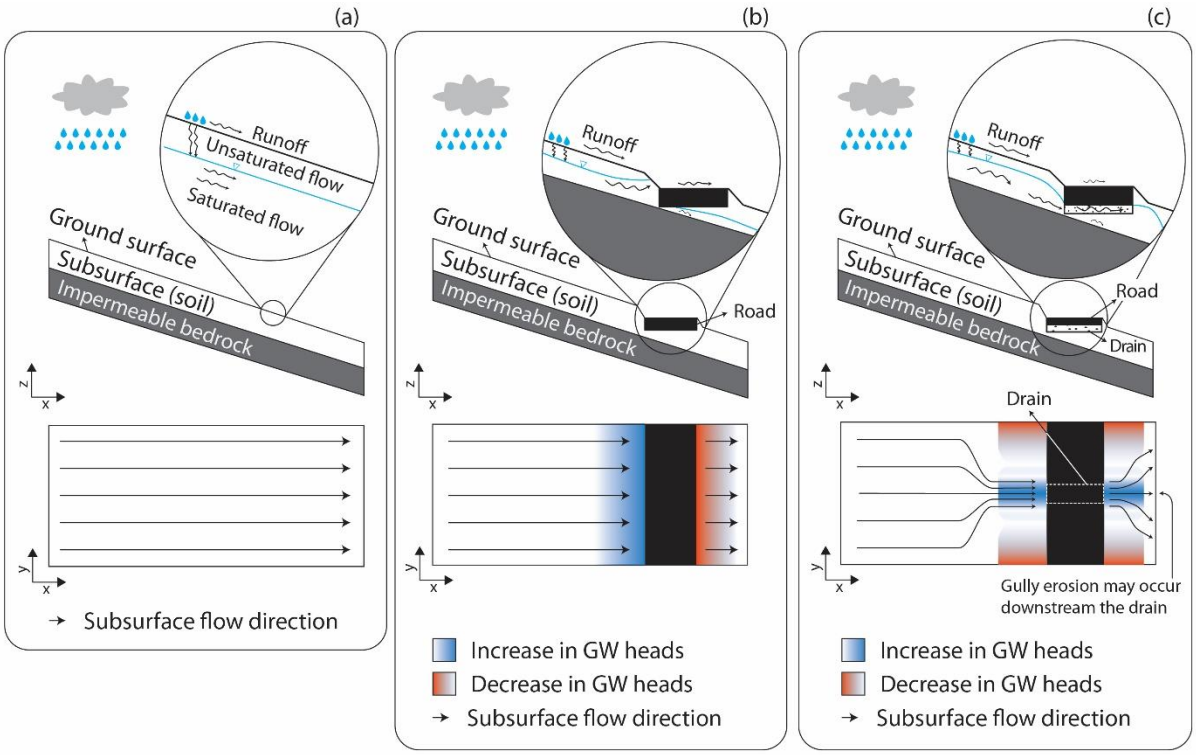
Spaces between numbers and units were removed as described in the guideline.

Line 59: Capital "V" for Von Sengbusch. It's the start of a new sentence.

Capital V was corrected.

Figure 1: The cross-sectional view suggests that the water could easily pass underneath the road. However, in the text you mentioned that the top soil is very thin so that the road blocks the water flow to a large extent (also indicated by the lower figure). Isn't the figure a bit misleading? I would just increase a bit the size of the road and additionally sketch the impermeable bedrock.

The size of the road in the figure 1 was increased and impermeable bedrock was added. In this way, the reader will directly understand that the groundwater is blocked upstream the road.



Line 126: "similar" or "comparable" instead of "same" would be a more suitable word in this regard.

"same" was replaced by "similar".

Line 131: I would add "bed" to "road bed structures"

"Bed" was added, now the sentence is: To evaluate the hydraulic connection provided by the road bed structures, tracer tests were carried out.

Line 156: I wouldn't use the term "indirectly indicates". I would write something like "clearly shows". At least, I would skip "indirectly".

The term "indirectly indicates" was removed and replaced by "clearly shows". Now the sentence is: An increase in EC in piezometers located in the downslope area indicates that the injected salt water flowed from the upslope area to the downslope area below the road and clearly shows a hydraulic connection.

Line 157: Here, it is the other way around. Instead of writing "this indicates that there is no connection", I would be more careful by writing "this indicates a strongly hampered hydraulic connection".

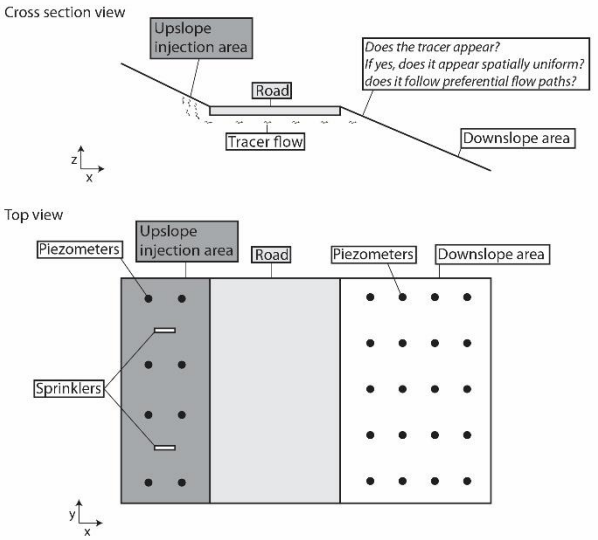
Yes it is more finely described if we use "strongly hampered" instead of "no connection". We also removed "finally a decrease in EC is not expected". After correction, the whole sentence is: Conversely, if no changes in EC are observed in piezometers, this indicates a strongly hampered hydraulic connection below the road.

Line 158: I would delete "and finally a decrease in EC is not expected". (It is just too obvious.)

We can remove this line if you think that it is too obvious.

Figure 3: For me, the cross sectional view is a bit superficial, but I guess this is a matter of taste: Still, the spaces before the question marks should be deleted. Moreover, I would just write "Piezometer" instead of "Mini-piezometer".

The figure 3 was modified according to your comments.



Line 163: What does "variable saturated" means? Sometimes saturated, sometimes unsaturated or variable hydraulic parameters? This should be explained more specific (I guess it is a terminology from HGS.)

Variably saturated means that change in saturation of the soil is simulated. However, is not important to mention that here. To be clearer, we changed "variably saturated subsurface water flow" by "subsurface water flow". The corrected sentence is: First, a 3D base case model representing surface and subsurface water flow in a sloping fen was elaborated.

Line 166: I would replace "produce a sensitivity analysis and explore their sensitivities in" just by "analyse their impact on". Calling it sensitivity analysis is not really wrong, but for my taste not well fitting.

In our opinion, it is a sensitivity analysis however, we can change. The suggested would be:

For each model, various slopes, organic soil and road drain hydraulic conductivities were implemented to produce a sensitivity analysis and analyse their impact on the sloping fen flow dynamics

Section 2.2.1: I would strongly shorten this section, as it is not really a part of your story. If somebody is interested in the mathematics behind your model, he/she would read the original publication of HGS. I would write a couple of lines mentioning the basic assumptions and methods, but no equations. In case you really want to keep them, I have some minor suggestions:

Yes you are true section may be reduced (reviewer 2 made the same comment). We keep only the main assumptions and method.

(i) You should give the equations in the same order as referred to in the text, i.e. 1st Richard, 2nd Saint Venant, 3rd Darcy. Or just mention the diffusion a bit later in your text; (ii) Eq 1 and Eq 2 are modified versions of the Richards and Darcy. This should be mentioned. (iii) Line 176: No need to explain "Nabla". It's the common notation; (iv)Line 178: Commonly, "Uppercase Theta" is used for water content and not for porosity;(v) Line 180: I would add "saturated". K is the "saturated" hydraulic conductivity:(Multiplying with kr results in the actual hydraulic conductivity.)

These lines were removed.

Line 207f: "was used on the right face" – left and right are just a matter orientation. Maybe you better write something like: The lowest cells of the slope constitute a constant head boundary condition.

Yes, it is better to use "the lowest cells of the slope" than "one the right face". After correction the sentence is: A constant groundwater head boundary condition (Dirichlet type) equal to the ground

surface elevation (2m) was used on the lowest cells of the slope (x=76m on the **Erreur ! Source du renvoi introuvable.**a) allowing the groundwater to flow out of the model

Line 218: Missing space between "2" and "m".

According to the guideline, we should not use a space between a number and an abbreviation of a unit. Therefore, we removed all spaces in the manuscript.

Line 234: Generally, I prefer the use of SI units, i.e. m/s instead of m/d.

As hydrogeologist, we also prefer m/s instead of m/d, however, the manuscript is not only hydrogeologist but for other environmental sciences such biologists. In my opinion, m/d provides greater clarity.

Line 256f: What do you mean by "length scale of one to several meters". Is this a common expression?

"length scale of one to several meters" is not a common expression but a mistake. We removed "length scale". Now the sentence is: In contrast, the EC maps established prior to the tracer test show a spatial variability of one to several meters

Line 257: "629uS/am" – What is this? I guess 629 _S/cm

Yes is 629µS/am. We corrected it. Thank you for carefully reading our paper!

Line 279: "local drying up of the soil)" – If you consider this as a problem, it would be quite easy to further investigate it with your numerical model. This would allow answering the question: how large is the affected area and to which extent it dries out?

Yes you are absolutely right. Therefore, a new figure (figure 9) was created in which we can see the extent of perturbations induced be the l-drain structure.

Figure 7: In column 2 and 3 you are showing EC values. I am wondering why you are using totally different graphical representations. Moreover, if you are interpolating (I am not a big fan of interpolation, if it is not really necessary: : :), you should state which method you are using. What kind of background map you are using? Does it tell us something?

This figure will be corrected and the background and the interpolation method will be specified.

Line 288-292: For me, these lines are superficial. I would just delete them.

We wanted to help the reader by describing each step of the result interpretation. If you think it is superficial, we can remove them.

Line 293-301: This is very trivial and doesn't need any explanation. It can be directly derived from the Darcy equation (at least for the base case model).

Yes it is trivial it can be directly derived from the Darcy equation. However, it seems important to describe the base case insofar as the base case is used to compare other results.

Line 316f: Are you sure that "may be" is the right expression here?

We modified the "may be" by "can be".

Figure 8-10: It is not very comfortable to analyse the differences between the different slopes. Can't you just put all figures together using a slope specific colour?

Yes it is true. We grouped together the three slopes.

Line 451: Is the year 2005 correct? I guess you want to refer to the manual, or? The one, I found, is from 2010.

Yes it was the former version. However we should use the new reference: Aquanty: HydroGeoSphere, a three-dimensional numerical model describing fully- integrated subsurface and surface flow and solute transport. Waterloo, ON, Canada., 2017.