To Reviewer Comment:

Following are my reply to the comments.

The reviewer's comments and questions are in bold, and my reply is in blue and normal text.

Line 49:
Typo is fixed. Thank you.

Line 50:
Typo is fixed. Thank you.

Line 59: amounts of modeling??
The sentence is written as: “GUI interface tools face difficulties in handling large amounts of modeling tasks.”

Line 60-61:Rewrite this sentence. Also, What do you really want to say here? Human participation is indispensable using GUI-based modeling or is it indispensable in general.
Human intervention decreases reproducibility, as different modelers may handle the data in various ways. For instance, the watershed delineation by different modelers can yield different results. Conversely, the results from automation always depend on parameters and rules, which are reproducible in different environments.

The sentence is rewritten as: “In modeling with GUI-tools, human participation is required instead of being controlled via modeling parameters, making it impossible to implement large number of hydrological modeling cases. ”

Line 66: But in the previous paragraph you say that it is impossible to do so? Please be clear.

I meant the GUI-tools cannot do such jobs, so we need intervention-free, reproducible, and automated tools.

The sentence is rewritten as: “Therefore, when dealing with a large number of watershed simulation tasks, both pre-processing and simulation post-processing necessitate the utilization of intervention-free, reproducible, and automated tools.”

Line 67-68: Write something about epistemic uncertainties here, and that a modeler needs to take care of these uncertainties according to their knowledge of the data. You can refer to several recent papers by Keith Beven to make these arguments. For example, see Beven (2019) in Porceedings of Royal Society

Thank you. We add following sentences:

“However, regardless of the modeling tools used, it encompasses epistemic uncertainty, affecting the final results and accuracy of hydrological simulations(Beven and Young, 2013; Beven, 2013, 2018, 2019). Various modeling tools can technically support the modeling process but cannot eliminate the inherent uncertainties in models and data. Users need to be vigilant about this”

Beven, K., 2013. So how much of your error is epistemic? Lessons from Japan and Italy. Hydrol. Process. 27, 1677–1680. https://doi.org/10.1002/hyp.9648

Beven, K.J., 2018. On hypothesis testing in hydrology: Why falsification of models is still a really good idea. WIREs Water 5, 1–8. https://doi.org/10.1002/wat2.1278

Beven, K., Young, P., 2013. A guide to good practice in modeling semantics for authors and referees. Water Resour. Res. 49, 5092–5098. https://doi.org/10.1002/wrcr.20393

Beven, K., 2019. Towards a methodology for testing models as hypotheses in the inexact sciences. Proc. R. Soc. A Math. Phys. Eng. Sci. 475. https://doi.org/10.1098/rspa.2018.0862

Line 93:

Typo is fixed. Thank you.

Line 147: What is unphysical about Hortonian and Dunnian flows? They both occur nature.

Here, we need to define what "physically" means. Physically means (1) laws are based on minimal assumptions and (2) these laws are applicable in both laboratory and field settings (at least in most scenarios). Both Hortonian and Dunnian are conceptual models for ideal slope runoff generation, and they cannot effectively apply under various slope gradients, soil textures, vegetation, and precedent soil moisture conditions. Detailed discussions on these two methods and similar mechanisms can be found in Beven (2012) (section 1.4, page 4-13, figure 1.4). In fact, both Hortonian and Dunnian mechanisms are conceptual models or expedients for calculating overland flow, rather than universally applicable physical laws. In contrast, the Darcy-Richards equation used in soil water calculations and the St Venant equation used for surface flow are based on fewer assumptions and have better adaptability on different slopes, hence can be considered as "physical." This also explains why the Darcy equation is sometimes referred to as Darcy's Laws. However, it should be noted that outside the scope of watershed Rainfall-Runoff models, the Darcy equation may not be an absolute truth.

Line 148: GA method is actually based on approximate theory which is surely not how water moves in soils.

The GA method is not a perfect approach for calculating infiltration in the topsoil. Although it is one of the physical methods that can be employed in a temporal-spatial continuum like numerical schemes. The foundation of the GA method still relies on Darcy's equation, assuming a sharp wetting front and uniform soil conductivity. It has its limitations. However, there is currently no purely physical equation or law that adequately describes the continuous vertical flux from the topsoil to the unsaturated zone and eventually to the saturated zone. Such a law should encompass the temporal-spatial continuum and account for preferential/ macropore flows. The GA method is not a purely physical or realistic representation, but it serves as a more physical and practical option for numerical methods.

Line 149:

Typo is fixed. Thank you.

Line 149:May be I am missing something here. But surface runoff is calculated using rainfall and infiltration runoff; the Manning's equation is used to compute flow height from the runoff .

In the SHUD model, the infiltration is calculated based on the height of ponding water on the land surface. The lateral runoff is calculated based on the residual water on surface after infiltration, in which the Manning's equation is applied.

Line 150:

Typo is fixed. Thank you.

Line 154-155: Again, If I am not wrong, Dupuit assumptions are used to approximate three dimensional flow as two or one dimensional flow.
Thank you.

The sentence is rewritten as: “The calculation of horizontal groundwater flux in horizontal direction is based on the Dupuit Assumption”

Line 278:
Typo is fixed.

Line 279: “The substantial difference in triangle area between the edges and inner parts significantly slows down model performance by unnecessarily increasing computations on the boundary” ?? how??

For example, the Waerma watershed has a total area 9.8 km2, whose boundary was built on the 30-meter DEM. Then the minimum line segments on the boundary is 30-meter. When we try to built a triangular mesh with ideal area 0.1 km2, the expected area of each triangle is 0.1km2 approximately. The actual number of triangles may be more than 98 (9.8 / 0.1).

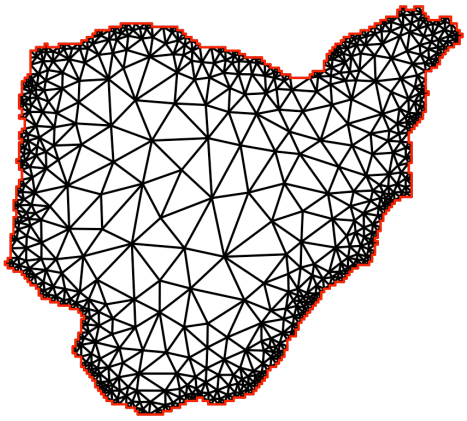
Here is two option:

1) To generate the mesh directly with the boundary from 30-meter DEM.

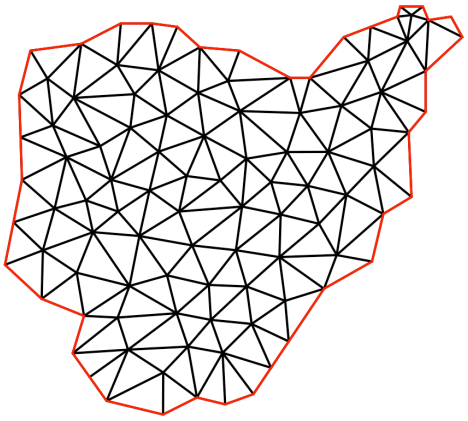
2) To simplify the boundary with tolerance 60-meter, then generate the mesh.

The results are shown in following figure:

(a) No Simplification



(b)Simplified (60m)



There are lots of small triangles near the boundary in the non-simplified boundary. These emergence of such triangles is due to the 30-meter boundary jigsaw. The the number of triangles in two scenarios are 1463 and 160 respectively.

The following R code can repeat the experiment.

```
clib=c('rgdal', 'rgeos', 'raster', 'sp', 'fields', 'xts')
x=lapply(clib, library, character.only=T)
library(rSHUD)

data("waerma")
wbd=waerma$wbd
x=spTransform(wbd, CRSobj = crs.Albers(wbd))
x1=x
x2=rgeos::gSimplify(x, tol=60)
amax = 1e5 #km2
y1=shud.triangle(wb=x1, q=30, a=amax)
y2=shud.triangle(wb=x2, q=30, a=amax)
png('vs.png', width = 7, height=4, res=400, unit = 'in')
par(mfrow=c(1, 2))
plot(y1, type='n', asp=1, main='(a) No Simplification')
plot(y2, type='n', asp=1, main='(b)Simplified (30m)')
dev.off()
print(nrow(y1$T))
print(nrow(y2$T))
```

Line 299: Higher of the orders of the two joining streams is used.

Thank you. The sentence is rewritten as: “In cases where two streams of different order join, the higher of the orders of the two joining streams is used.”

Line 309-310:Unclear. Are you not calculating the average of slopes of small segments within the reach?

The calculation of river reach slope is the elevation differences and distance between the start and end points, instead of the average of slope of each segments within the reach.

Line 333: What do you mean by 'may contain'? Typically, a cell is a homogeneous unit right?

Thank you. The sentence is rewritten as: “a cell contains only one soil type without heterogeneity within the cell.”

Line 334-335: So, a cell is a homogeneous unit.

Yes. A cell is a homogeneous unit.

Line 364: TSD?

TSD stands for Time-Series Data. The first TSD is in Line 196.

Line 370: Should it not vary depending upon the if the year is leap year or not?

Thank you. At the end of the paragraph, we add a sentence:

"The denominator 366, which represents a leap year, is replaced with 365 for a common year."

Line 476: There should be a brief discussion of the data uncertainties because estimating uncertainties in data is a pre-processing task. It would be prudent to make reader aware that the need to consider uncertainties in data on their own and it is not done by the rSHUD package.

Thank you.

We add a paragraph:

"Uncertainty is crucial in hydrological modeling and must be considered even when using the rSHUD package for model deployment. Users should acknowledge uncertainties in data inputs and model parameters, which may arise from measurement errors, natural variability, or limitations in the package's model structure and parameterization. The equations and data embedded within rSHUD package also introduce uncertainties. Users of the rSHUD package should therefore conduct a thorough uncertainty analysis as a preprocessing step to ensure the reliability and robustness of their modeling outcomes."

To Polina Shvedko Comment:

It seems that table is included as figure #5. If it is so, it must be re-labelled as table and the references in the manuscript text must be adjusted accordingly.

We confirmed. We labeled the figure 5 on purpose. Even though the content in figure 5 are tables, but they represent the linkage of the files, so the figures are preferred.