Referee comment for:

r.sim.terrain: a dynamic landscape evolution model

by B.A. Harmon et al. (2019)

General comments:

Overall, the paper presents a novel and interesting model that fills gaps in the current modelling literature around the landscape evolution associated with gully erosion. It outlines the strengths of different models (RUSLE, USPED, and SIMWE) to simulate change at different spatial and temporal scales, and the equations that influence sediment flow and transport, and thus the landscape evolution. A case study is presented showing how the model simulates the development of ephemeral gullies, rills, and hillslopes under the same 120min rainfall event but for different intensities and erosion regimes. This type of model is of interest to the community around Geoscientific Model Development

Although the difference between steady-state and dynamic flow regimes is discussed, the differences between the erosion regimes (e.g. detachment capacity limited, transport capacity limited, erosion-deposition and detachment limited) are less clear. A more thorough discussion of those regimes and their differences would allow for a clearer understanding of the results of the model compared to the typical characteristics associated with these regimes. On P16 L24 to L27, the results of SIMWE were compared to the characteristics typical of the simulated erosion regime. Establishing the characteristics of the erosion regimes earlier, perhaps after the explanation of the flow regimes, would give the reader more clarity regarding what influences these regimes and how the model compares to real-world characteristics.

Given that the study area has information for 2012 and 2016, one possible improvement is to compare the model results to the observed difference between those two years. Although the results section on P16 compares the modelled characteristics with typical erosion regime characteristics, the comparison to the 2012-2016 data is limited to P16 L23. Adding validation of model results against observed landscape evolution would show the strengths of the model.

Another possible improvement is to more clearly present the limitations of the model in their own section. On P4 L22, the model limitation of not modelling fluvial processes is mentioned. By having a clear limitations section with information about model assumptions, the reader is more informed about the model and how it may affect results.

The quality of the figures and the presentation of spatial data is a major issue of the paper. With the exception of Figure 1, many of the figures are too small to be analysed in detail. The legends are pixelated (Figure 4c, 4e, and 4f) or cut off (Figure 5a and 5d). The legends for the landform maps (Figures 5b, 5e, 6b, and 6e) would benefit from the labels presented in Figures 4e and 4f.

The colours chosen for the figures could also be improved. For example, Figure 2b shows a landscape with yellow/orange/blue colours but the colourbar only shows a scale of yellow to orange. Using the hillshade layer seems to darken the colours within the gully and the reader is unable to clearly see those colours.

The use of a 3D top-down view in Figure 5 makes it difficult to see what is occurring within the gully area where the differences are most important. Some figures are presenting differences (Figure 5c, 5f, 6c) that cannot be visualised clearly because most of them are occurring within the gully area and thus “blocked” by the 3D view and hillshade.

Overall, the figures can be improved, especially for visualisation of the key results and differences, and that would contribute to the overall quality of the paper. The differences may be better visualised through 2D top-down view, or 2D cross-sections, or even zooming into the most critical areas of the gully. At the watershed scale and using the current visualisation, the results are difficult to visually interpret and do not supplement the written results well.

Specific comments:

- P3, L22: According to Dabney et al. (2014), RUSLER refers to RUSLE2-Raster which is a distributed form of the Revised Universal Soil Loss Equation Version 2, which is normally referred to as RUSLE2. The paper is referring to the Revised Universal Soil Loss Equation Version 2 when it is using the RUSLE2-Raster acronym. Please clarify if the paper is referring to RUSLER or RUSLE2.
- P6, L11 to P7, L6: This paragraph would be better presented in a table or a flowchart showing how the model switches erosion regimes based on rainfall intensity.
- P14, L11 to L13: Additional detail about how the information about K-factor, C-factors, Manning's, and runoff rates were derived would be useful for those who wish to apply the model in their study area.

Technical corrections:

- P3, L17: Since LIDAR is an acronym for Light Detection and Ranging, mentions of LIDAR should be in capitals and the first instance should have the accompanying meaning of LIDAR.
- P4, L28 and similar headings: For these headings, referee suggests formatting as follows "Simulation of Water Erosion Model (SIMWE)" and only using the acronym on the following line.
- P6, Table 1: Citation of "(Dennis C. Flanagan et al., 2013)" should just be "(Flanagan et al., 2013)"
- P10, L15: The addition of "(a)" after "The upslope contributing area per unit width" would allow for a clearer connection to Equation 12.
- P13, L14 and P14, L1: Scientific names should be italicised.

References:

Dabney, S., Vieria, D., Bingner, R., Yoder, D., and Altinakar, M.: Modeling Agricultural Sheet, Rill and Ephemeral Gully Erosion, in: ICHE 2014. Proceedings of the 11th International Conference on Hydroscience & Engineering, pp. 1119-1126, Karlsruhe, 2014.