Brief comment: This study observed erosion processes and some soil-hydrological properties at the headcut areas of two permanent gullies in Northeast China's Mollisols region during rainy and snow-melting seasons. Key parameters like soil moisture, temperature, and precipitation were investigated to understand water storage capacity, leakage processes, and suction stress levels. Although only two headcuts were monitored, I think the results could be of interest for the scientific community, but I would only recommend the publication of the work if a series of changes and improvements are carried out. In my opinion, the authors wrongly include methodological content and interpretations in the results section. These contents should be rightly placed in the corresponding section. Additionally, I miss some methodological details that I consider relevant (UAV data, processing, etc. see my comments below). Finally, figures must be notably improved, particularly the font size, please see my comments below. I detail these suggestions in the following lines:

Replies:

Thanks for your comments to improve the quality of this manuscript.

Firstly, the physical process of gravitational soil erosion in permanent gully has been long neglected in the soil-water conservation research field, while it plays an important role in permanent gully expansion and development. In this work, we clearly addressed their differences and similarities with the landslides and used the theory of unsaturated soil mechanics to study their physical process.

As you suggested, we should clearly state some methodological content and interpretations in the method part, not in the results part. Meanwhile, some short paragraph in the results part should be moved into discussion part. We also found that the texts in some figures are not clear enough to read and some errors exists. Therefore, we made a thorough revision of this manuscript and the figures.

We made a throughout revision for the previous manuscript. **Please see the manuscript with marked changes and accepted changes.**

We made a point-to-point response to your comments, as follows:

Comment 1

Abstract: I have doubts about the last sentence as the USLE was not designed to predict gully erosion. I would recommend to delete this sentence.

Reply 1

Done. We revised the last sentence of in the abstract. As you know, USLE is an empirically-based function. If a physically-based function is developed to predict the gully erosion, it will be better. We revised the last sentence in the abstract into: The findings of this study could deepen our understanding of the physical process of permanent gully development from the perspective of hydrological and hydro-mechanics behavior of gully head-cut.

Comment 2

Figure 1. Should be improved, China is floating in the white. In general, some items in the figures are difficult to read, for example legend items in Figure 1c, the location map between 1b and 1c is impossible to see.

Reply 2

Done.

The other two reviewers also mentioned the quality of figure 1.

We revised the figure 1. The new figure is shown as follows:

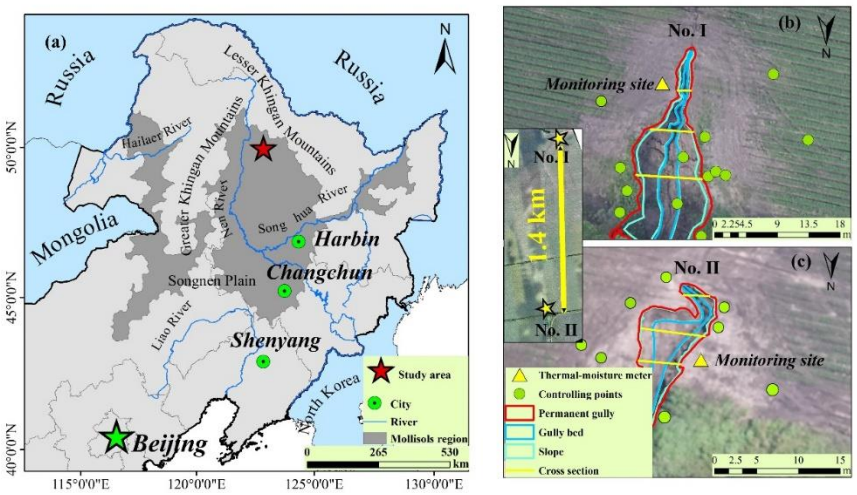


Fig. 1. Location of the two permanent gullies in the Mollisols region of northeast China. **(a)** The red star marks observation site in the study area (from ESRI). **(b)** Monitoring sites and ground controlling points at permanent gully No. I. **(c)** Monitoring sites and ground controlling points at permanent gully No. II. (background of **a** is from ESRI; areal maps of **b** and **c** are from UAV by Shoupeng Wang; the area between the blue lines mark gully bed, and the area between pink and blue lines mark the steep slope).

Comment 3

Fig. 2 Again some labels are very difficult to read, for example H in b.

Reply 3

Done.

Some labels in figure 2 are difficult to see. We improved the quality of the figure 2. The revised figure 2 is shown as follows:

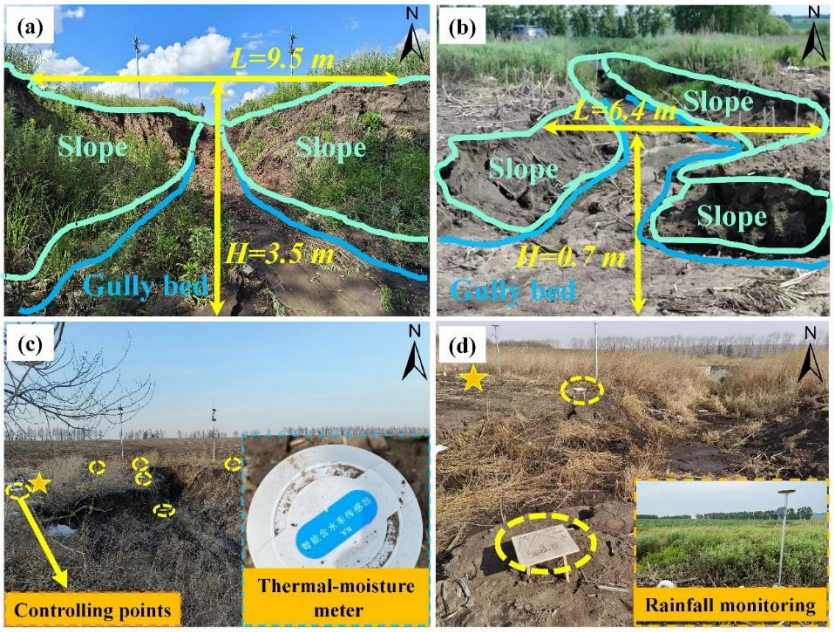


Fig. 2. A close view of the over-steepen slope and headcut of the two permanent gullies, with **(a)** cross section and upstream view of the permanent gully No. I, **(b)** cross section and downstream view of the permanent gully No.

II, **(c)** ground controlling points (blue dot circles) and the soil moisture-temperature monitoring site (yellow star) at permanent gully No. I, and **(d)** ground controlling points and the soil moisture-temperature monitoring sites at permanent gully No. II. The location of headcut of the two gullies is shown in fig. 1. The area between blue lines marks the gully bed. The area between the pink and blue lines marks the slope.

Comment 4

L150 monitoring instead "observation work"

Reply 4

Done.

We already revised it.

Comment 5

Section 3.1 How many flights did you carry out? what was the monitoring period? dates, UAV type, resolution? I miss so many details here.

Reply 5

Ok.

The other two reviewers also mentioned what you said here. We also found that we missed the important flights during the study period. We should give a clear description of the detailed information of the flights and monitoring period, dates, UAV type and the resolution of the digitized elevation model.

In the revised manuscription, we clearly presented the missing information in the second paragraph of section 3.1: "To observe the gravitational mass-wasting process during the rainy and melting seasons, the study area was scanned by numerous control plates (the dots in Figs. 1a and 1b, and dashed circles in Figs. 2c and 2d), installed in and around the gully area and used unmanned aerial vehicle. These control points were used to analyze the accuracy of the UAV-derived map and digital elevation model, aiming to obtain highly accurate topography. During the melting season in 2023 and the rainy season in 2022, three flights on 28 June 2022, 17 October 2022, and 20 June 2023, were implemented with same flight routine and image overlap. We used Pix4D software to process image synthesis and the gully topography producing, which can reallocate the point cloud and filter the points of vegetation layer. As the points of vegetation layer (mainly the grass leaf) is changeable in plant height while the ground point is fixable, the vegetation layer could be filtered out and removed through the filtering tool. The DEMs products were spatially registered in ArcGIS 10.2 by a standard layer of orthoimage, ground control points, and the spline function (Table 1). Then, the erosion depth of the headcut area could be obtained by the differences between two DEMs. Therefore, the linear and the erosion intensity can be calculated using the erosion depth and the grid size. Then, the differences between two digital elevation models generated the positive and negative terrain, which quantitatively showed the erosion intensity of the gravitational mass-wasting. Additionally, the eroded soil volume in the unit over-steepen slope surface area, termed erosion per unit area, was applied in this work to address the erosion intensity of gravitational mass-wasting."

Table 1. Detailed information of three UAV flights and the digital elevation models

UAV model	Flight date	Flight height (m)	DEM Accuracy (m)	Image overlap (%)
DJI Inspire 2 RTK	2022.06.28	200	0.058	80
DJI Phantom 4 RTK	2022.10.17	500	0.108	80
DJI Phantom 4 RTK	2023.06.21	150	0.042	80

Comment 6

L213-219 This is methodology and should be placed there, for example in section 3.1

Reply 6

Yes. We adopted your suggestion here. We revised the second paragraph in section 3.1: "To observe the gravitational mass-wasting process during the rainy and melting seasons, the study area was scanned by numerous control plates (the dots in Figs. 1a and 1b, and dashed circles in Figs. 2c and 2d), installed in and around the gully area and used unmanned aerial vehicle. These control points were used to analyze the accuracy of the UAV-derived map and digital elevation model, aiming to obtain highly accurate topography. During the melting season in 2023 and the rainy season in 2022, three flights on 28 June 2022, 17 October 2022, and 20 June 2023, were implemented with same flight routine and image overlap. We used Pix4D software to process image synthesis and the gully topography producing, which can reallocate the point cloud and filter the points of vegetation layer. As the points of vegetation layer (mainly the grass leaf) is changeable in plant height while the ground point is fixable, the vegetation layer could be filtered out and removed through the filtering tool. The DEMs products were spatially registered in ArcGIS 10.2 by a standard layer of orthoimage, ground control points, and the spline function (Table 1). Then, the erosion depth of the headcut area could be obtained by the differences between two DEMs. Therefore, the linear and the erosion intensity can be calculated using the erosion depth and the grid size. Then, the differences between two digital elevation models generated the positive and negative terrain, which quantitatively showed the erosion intensity of the gravitational mass-wasting. Additionally, the eroded soil volume in the unit over-steepen slope surface area, termed erosion per unit area, was applied in this work to address the erosion intensity of gravitational mass-wasting."

Table 1. Detailed information of three UAV flights and the digital elevation models

UAV model	Flight date	Flight height (m)	DEM Accuracy (m)	Image overlap (%)
DJI Inspire 2 RTK	2022.06.28	200	0.058	80
DJI Phantom 4 RTK	2022.10.17	500	0.108	80
DJI Phantom 4 RTK	2023.06.21	150	0.042	80

Comment 7

RESULTS: there are many interpretations of the results that, in my opinion, are discussions more than objective results, therefore, I suggest to move these sentences to the corresponding section and use the results just for the objective introduction of observed data or processes.

Reply 7

Done.

We checked the results section and some paragraphs should be in the discussion part. Except some brief interpretations before a result section (we already moved to corresponding section, either in the method section or the discussion section), four paragraphs should be moved, they are "the second paragraph of 4.1 section, the third paragraph of 4.4 section, and the first and the fourth paragraph of 4.3.2 section. The 4.2 and 4.3 section clearly gave the objective introduction of the observed data and analysis.

The second paragraph of 4.1 section act a connecting role to the following result section. It gave a brief analysis about and clear explanation on the 4.2, 4.3 and 4.4 section. Of course, the first sentence with citations has been deleted because it is useless. Therefore, we suggest that keep the revised second paragraph of 4.1 section.

The third paragraph of 4.4 section cited a reference, aiming to compare the rainfall threshold. We revised this paragraph, and merely keep the objective results. For the rainfall threshold comparison, we moved them into the discussion section.

The first paragraph of 4.3.2 section repeated with some sentences in the discussion part and

the fourth paragraph of 4.3.2 section. Therefore, he fourth paragraph of 4.3.2 section should be kept and the first paragraph of 4.3.2 section should be merged into the discussion section.

Comment 8

L241- These instead this

Reply 8

Done. Thanks a lot.

We already revised it.

Comment 9

L281 - Soil instead soi

Reply 9

Done. Sorry to make such a mistake here. Thanks for your kind reminding.

We already revised it.

Comment 10

L271- I think you used this acronym before

Reply 10

Yes.

We used this acronym before, so we revised it into full text.

Comment 11

L315-139 - Again methodological issues in the results section.

Reply 11

Yes. After we read the previous manuscript again, we found some methodological issues should be in the results section. Meanwhile, we revised the methodology, results and discussions part.

We already moved it into the last paragraph of the methodology part.

Comment 12

L321- 0,15ºC per day? specify

Reply 12

Yes. You're right here. Thanks for your reminding here.

We already added "per day" after the number.

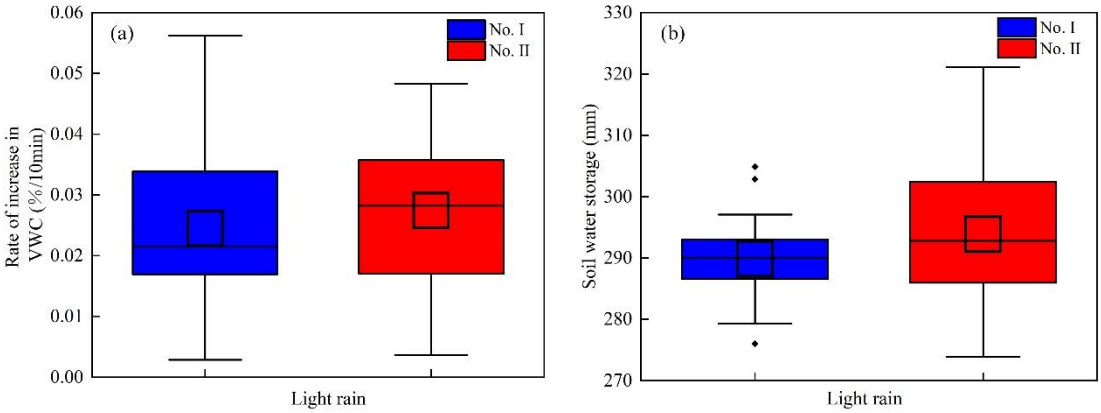
Comment 13

Fig. 8- I cannot see some details in (a), also happens in Fig. 9 (b)

Reply 13

Done.

We added a new figure to give a clear presentation of the figs. 8a and 9b.



The caption of the new figure is: **Fig. 9.** Hydrologic behavior for gully headcut during light rain events. (**a**) relatively lower rate of increasing of VWC for gully No. I. **(b)** relatively higher soil water storage for gully No. II. The three crossing lines of box show the 75th quantile (Q_3), median (Q_2), and 25th quantile (Q_1) from top to bottom. The length of the box is referred to as the interquartile range (IQR= Q_3- Q_1). The crossed square inside the box is the average value. The upper limit and lower limit of whiskers are Q_3+1.5IQR and Q_3−1.5IQR, respectively. The solid squares are the outliers.

Comment 14

L356-Avoid citations in the results.

Reply 14

Done. Results part should gave objective description of the founding.

We already deleted the citation in the results.

Comment 15

Fig. 10- the title of X-axis is not visible

Reply 15

Done.

I'm worry here to miss the title of X-axis in figure 10.

We already revised it. Besides, the other two reviewers mentioned me that the R^2 is not enough to support the significance of the fitted line. So, I inserted the P value in figs. 10a and 10b.

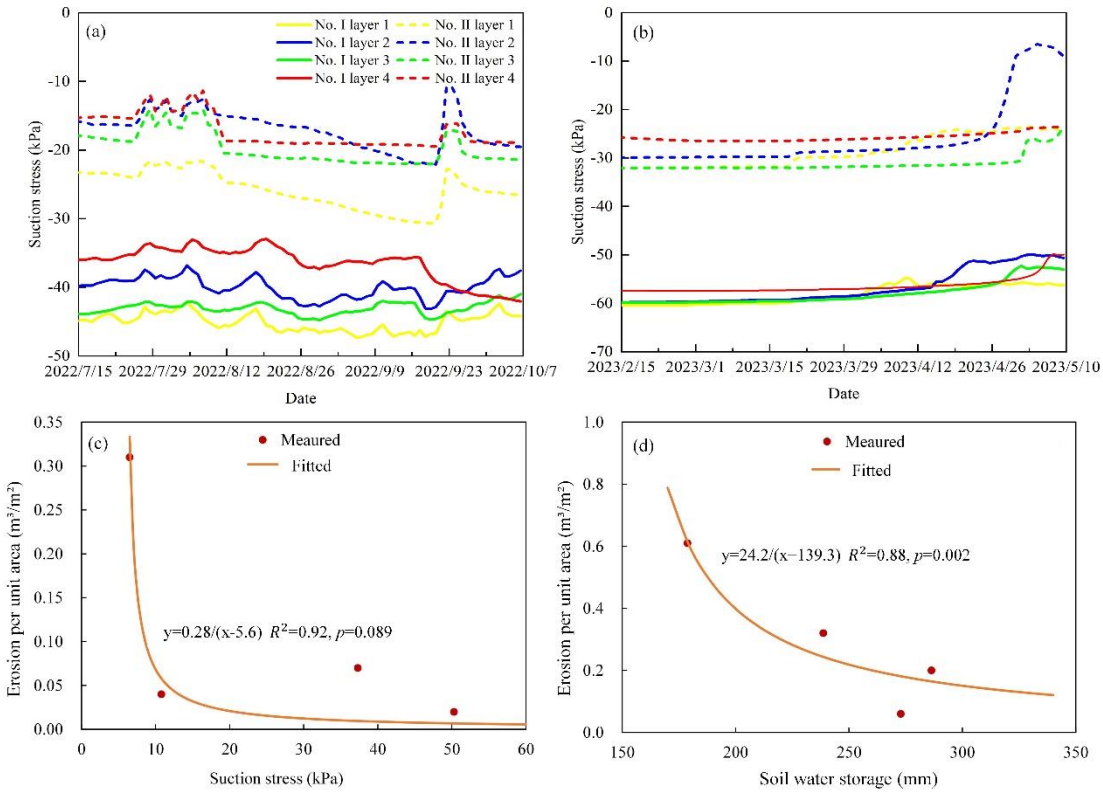
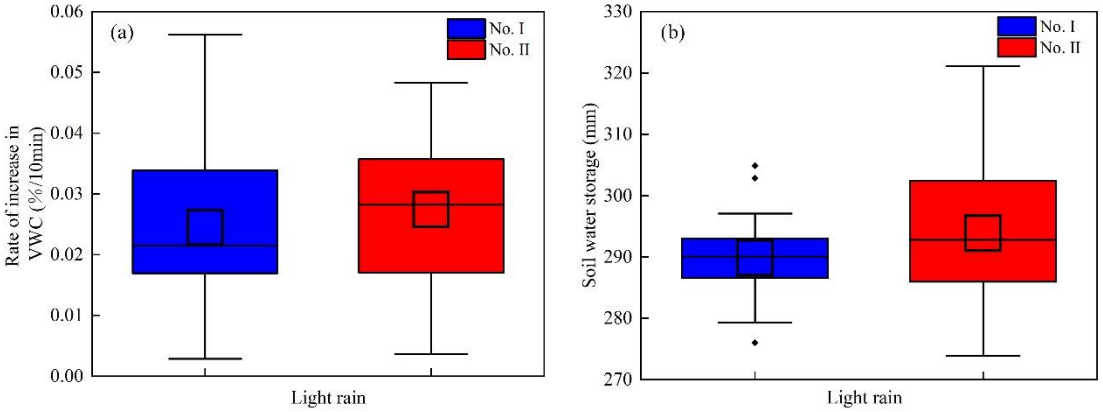


Fig. 11. Relationship between hydrology and the hydro-mechanical state with the erosion intensity. **(a)** Suction stress during the rainy season. **(b)** Suction stress during the snow-melting season. **(c)** erosion per unit area on over-steepen slope decreases with suction stress. **(d)** erosion per unit area on channel bed decreases with water storage amount.

Comment 16

Additionally, we added a new figure (corresponding to the comment 13)



The caption of the new figure is: **Fig. 9.** Hydrologic behavior for gully headcut during light rain events. (**a**) relatively lower rate of increasing of VWC for gully No. I. **(b)** relatively higher soil water storage for gully No. II. The three crossing lines of box show the 75th quantile (Q_3), median (Q_2), and 25th quantile (Q_1) from top to bottom. The length of the box is referred to as the interquartile range (IQR= Q_3- Q_1). The crossed square inside the box is the average value. The upper limit and lower limit of whiskers are Q_3+1.5IQR and Q_3−1.5IQR, respectively. The solid squares are the outliers.