Comment: This study explained the erosion intensity of gravitational mass-wasting at gully head by soil water storage and drainage, and the suction stress etc. Two permanent gullies were selected and studied in Northeast China's Mollisols region. It is interesting that understanding permanent gully expansion from both classical mechanics and the state of stress perspectives. However, I don't think this paper could be published before major reversion.

Replies: Jianjun, Thanks for your valuable comments.

Thanks for your recognitions for our works, this manuscript needs a throughout revision and we followed most of the comments from you and other two reviewers.

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

This work firstly examines the soil loss at headcut area of permanent gully in the Mollisols region of Northeast China. Currently, no one addresses the hydro-mechanical properties of mollisols and find the relationship between erosion per unit area and the soil suction stress and water storage. The occurrence of gravitational mass movement share similar mechanics as soil slips and avalanches while their scale are too small to monitor. Therefore, the only and feasible way to know about their occurrence and erosion intensity should combine the hydrological monitoring and the unsaturated soil mechanics. This work could give the physical process and the mechanics of gravitational mass movement. Therefore, we believe that our work would contribute greatly to the study field of soil erosion, attract more focus for scholars in the soil-water-conservation, and deserves to be published.

What I concerned is that

Comment: method part: the erosion volume derived from the UAV images based on the DoD (difference of DEM). DoD, as a typical method in 2D, may lead to the large uncertainty on the slopes, especially on the over-steepen slopes. For example, Fig. 3 in Kang, H., Wang, W., Guo, M., Li, J., & Shi, Q. (2021). How does land use/cover influence gully head retreat rates? An in-situ simulation experiment of rainfall and upstream inflow in the gullied loess region, China. *Land Degradation & Development, 32*(9), 2789-2804. In this case, DoD was suitable for Fig. 3a condition, but not for Fig. 3b. Both conditions are typically at the gully head. The solution includes but not limited: M3C2 (Gao, C., Li, P., Hu, J., Yan, L., Latifi, H., Yao, W., Hao, M., Gao, J., Dang, T., & Zhang, S. (2021). Development of gully erosion processes: A 3D investigation based on field scouring experiments and laser scanning. Remote Sensing of Environment, 265, 112683). Furthermore, we noticed there were many vegetation in the gully, which may also result in large uncertainties in volume calculation because vegetation obscures the ground information that reflect erosion truly. If a LiDAR UAV with your used in this study, its ok. Please clarify this part in the methods.

Replies: Good and professional comments here.

Firstly, DoD, e.g., the difference of DEM, is a 3D (it has *x*, *y*, and *z* orientations, not 2D) method to find the topography change. Uncertainty (or errors of DEM) on the slopes is a problem in finding the topography change if there were no fixed objects (aiming for image and DEM registration) in the images. Therefore, we used lots of fixed control points to minimize the uncertainties. Meanwhile, we used same flight routine (flight direction is vertical to the channel descending) and overlap ratio to cover the headcut area. Therefore, three aspects, fixed control points, same flight routine, flight direct to channel descending, were used to ensure the topography data accuracy.

Secondly, what you said that the DoD method performs well under certain conditions (such as Figure 3a), yet may be limited in others (such as Figure 3b), particularly in complex topographies like gully heads. This fact is true in your study area (may be gravitational mass movement in the headcut of gully in Loess Plateau), but not so in this work. In fact, the reason why two gullies were chosen for study in this work lies in that their cross section is not reverse V type. If the cross section exhibits reverse V type, we will establish a bending stability model to examine their occurrence, not the hydro-mechanical method. Importantly, you can see the channel cross section of figure 3 that the cross section exhibits V to U type, not the reverse V type. As you know, the reverse V type would generate some shadow area (as far as I know from field investigations in Loess Plateau) and the topography at the steep slope cannot be obtained, but can be handled by Lidar.

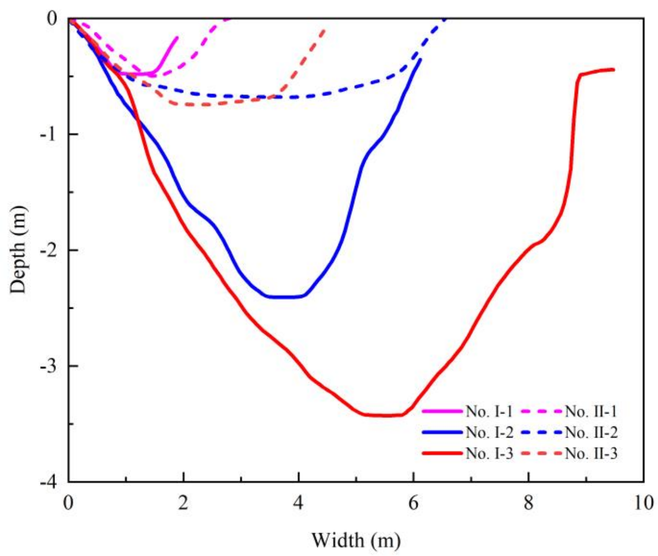
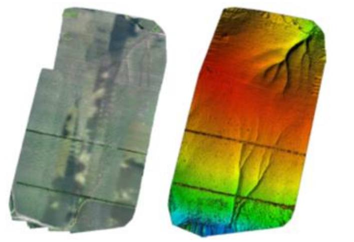
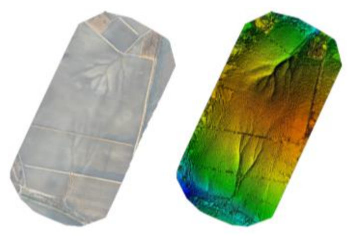
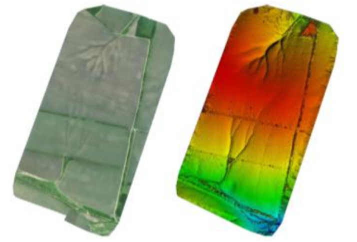


Figure 4 clearly shows the V or U cross section profile, not the reverse V type.

Thirdly, 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. Following manual screening to ensure the removal of any residual vegetation layer point clouds, the elevation data was regenerated, yielding a processed Digital Elevation Model (DEM) for the watershed.

The orthomosaic images and corresponding digital elevation models are shown as follows:

Date: 2022.06.28	Date: 2022.10.17	Date: 2023.06.21
		

The new table is：

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

Vegetation processing involved the following steps:

Step 1. 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.

Step 2. Following manual screening to ensure the removal of any residual vegetation layer point clouds, the elevation data was regenerated, yielding a processed Digital Elevation Model (DEM) for the watershed.

Step 3. The erosion mainly occurs in the slope area and the gully bed area. For sites beyond the gully area, the topography change does not consider in our works as these sites are flatten and not in the gully area. Therefore, gully edges were delineated through visual interpretation of RGB optical images, with efforts made to exclude vegetation on the banks to the greatest extent possible.

The DEM was resampled to 0.10 m using ArcGIS 10.8 software. Ground control points were employed to perform local precise registration of the drone aerial imagery within ArcGIS 10.8, thereby minimizing errors in gully delineation. These ground control points were also utilized to enhance the accuracy of three DEMs.

Comment: Paper was not well organized. Method part was not completed, missing UAV, remote sensing data processing and erosion volume calculation, some figures. Many paragraphs in results part should in method or discussion part. Discussion part should be in serval sanctions corresponding to the results part.

Replies: Done

After we read the comments provided by you and the other two reviewers, we found that three aspects should be improved: first, the missing UAV information; second, some part should be moved to method or discussion part; third, strength the discussion part. We are deeply grateful for your professional feedback. We already make a throughout revision for the previous manuscript.

Comment: This paper mentioned rainy season and snow-melting season, and erosion intensity in different seasons was analyzed (Fig. 4). But this paper not analyzed how factors influencing erosion intensity in different season. In other words, whether soil properties, hydrology, soil water have variation between seasons? This issue is critical to the whole story.

Replies: Good suggestion and comment here.

We should strengthen what you said in the discussion part.

We added a discussion sentence to address what you said in the third paragraph of Discussion: "The headcut of gully No. II is greatly disturbed, which may result in higher permeability, quicker water pressure response, higher soil moisture status either in rainy season or snow-melting season. Meanwhile, the soil suction stress is lower and slope erosion is more intensity than those of gully No. I. Note that the distance between the two gullies is merely 1.4 km and the climatic conditions is similar. Therefore, it seems that the soil properties may be the dominant intrinsic factors governing erosion intensity of gully slope."

There are some specific suggestions below:

Comment: The place name in Fig. 1 Haerbin should be Harbin, right? And the xing'an range, is the same with L120 Khingan Mountains?

Replies: Done.

Thanks for your patience and recommendations here. It greatly improves the quality of our text, figures and tables.

You're right here. Haerbin should be Harbin

Xing'an range is same with Khingan Mountains

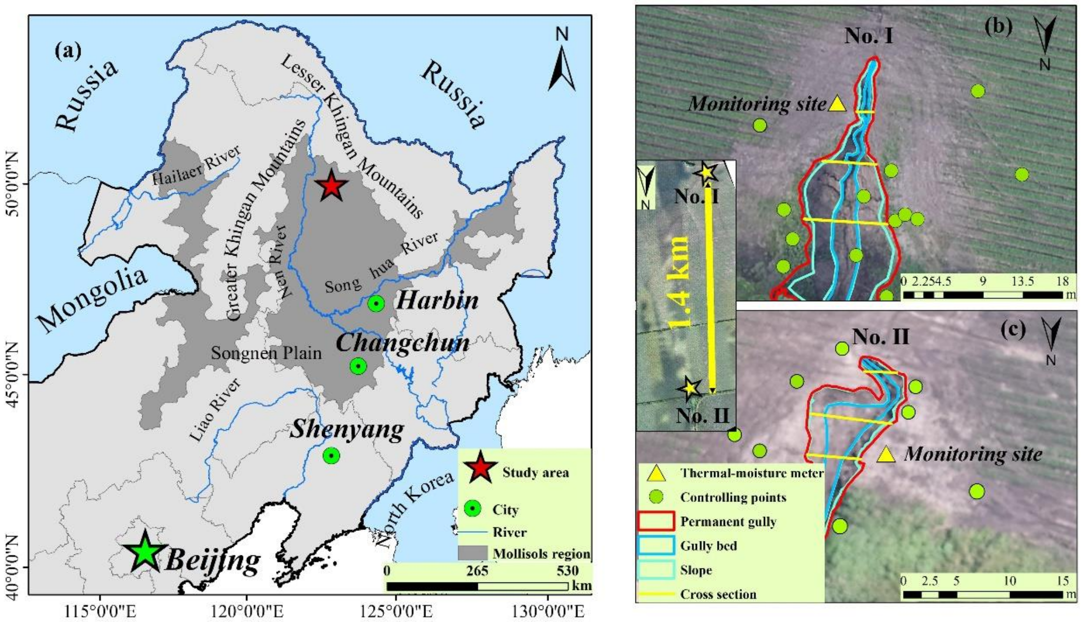


Fig. 1. Location of the two permanent gullies in the Mollisols region of northeast China. **(a)** The red star marks observation site in the study area (from ESRI). **(b)** Monitoring sites and ground controlling points at permanent gully No. I. **(c)** Monitoring sites and ground controlling points 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: L132-133 both number was I?

Replies: Sorry to make a mistake here.

We revised it into "Moreover, the height and width of gully No. II are lower than those of gully No. I (Fig. 3), and the head-cut area of gully No. II experienced tillage activities, while the headcut area of gully No. I does not."

Comment: L181-182 Formatting

Replies: Sorry to make a mistake here.

We revised it "$b_{\downarrow}$ is the dissipation proxy reflecting the water drainage ability of soil mass at given confining pressure, and reflects the concavity of the pore water pressure dissipation curve."

Comment: L216-219 should be method

Replies: Yes.

We already moved them in the method part.

Comment: L223 bed area? Slope area?

Replies: Ok.

We should write a clear description about the erosion per unit area.

In the revised manuscript, we wrote a clear description about the erosion per unit area by paragraph of rainy season and snow-melting season.

The revised parts are shown as follows (three paragraphs):

The erosion per unit area in both bed and slope area in the snow-melting season for gully No. I was greater than that in gully No. II (Fig. 4), which could be driven by the low melting water storage and high melting water runoff at the headcut of gully No. I.

In the rainy season, the erosion per unit area for bed of No. II gully was notably greater than that in gully No. I, which may result from the rapid water storage and leakage, producing intensive runoff at the headcut of gully No. II. The erosion of the over-steepen slope was mainly from the gravitational mass-wasting process. For gully No. II, the erosion per unit area in the snow-melting season was significantly greater compared to that in the rainy season.

In the snow-melting season, the erosion per unit area for slope of No. II gully was greater than that in gully No. I. Though the erosion per unit area in the rainy season for gully No. I was higher than that for gully No. II, the difference was as negligible as that in snow-melting season. It is important to note that the slopes of the permanent gully were over-steepen, and the stability of the slope primarily depended on the soil suction stress, as a function of the hydro-mechanical properties and the soil moisture."

Comment: L234 discussion?

Replies: Done.

We already moved them into the discussion part.

Comment: L285 method?

Replies: No.

It should be in the result part, not in the method part.

Line 285 in previous manuscript shows the contents of parameters describing the soil and water characteristic curve (SWCC) and the hydraulic conductivity function (HCF).

Comment: L290-297 method?

Replies: Done.

It should be in the method part (3.3 Hydro-mechanical property).

Comment: In Figure 10, the sample size is too small, so the R square is meaningless, and the significance p-value should be shown.

Replies: Done.

Thanks for your comments and suggestions here. we added the R square and the significance p-value in the figure 10 (figure 11 in the revised manuscript).

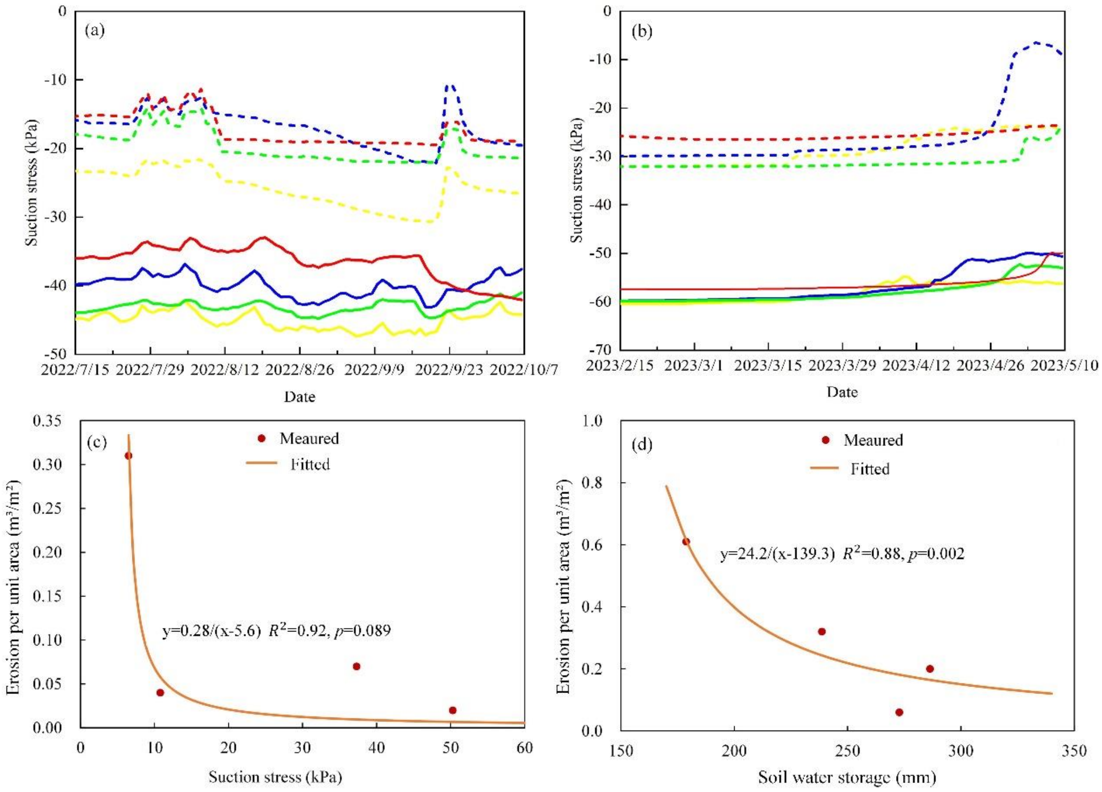


Fig. 11. Relationship between hydrology and the hydro-mechanical state with the erosion intensity. **(a)** Suction stress during the rainy season. **(b)** Suction stress during the snow-melting season. **(c)** erosion per unit area on over-steepen slope decreases with suction stress. **(d)** erosion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