NHESS-2024-91

Review to Flood hazard mapping and disaster prevention recommendations based on detailed topographical analysis in Khovd City, Western Mongolia, Author(s): Narangerel Serdyanjiv et al., MS No.: nhess-2024-91

RC1: Comment on nhess-2024-91, Anonymous referee #1, 18 Jul 2024

First of all, many thanks for all your valuable comments and suggestions. Please see below for changes based on your comments.

General comments:

In the study "Flood hazard mapping and disaster prevention recommendations based on detailed topographical analysis in Khovd City, Western Mongolia", authors present rainfall runoff maps based on digital elevation data derived from UAV flights.

1.1. Unfortunately, the study lacks novelty and evaluations lack scientific quality. Results are of interest to local decision-makers but do not contribute scientifically enough on their own. Other than stated in the introduction, riverine flooding is not accounted for, but only surface runoff.

Yes, you're right, this study is more than a theory, it describes the natural disaster risk situation that the region is facing and aims to provide scientific recommendations to policy makers in the region to prevent floods. We mainly focused on the development of flood hazard mapping (surface water runoff and flash flooding) based on UAV. Changes have been made to the abstract section of the manuscript based on your comments. It Included:

Abstract. *The impacts of climate change manifest heterogeneously across regions, and in Khovd City, a semi-arid area in Western Mongolia, the escalating threat of flooding is evident through the occurrence of 10 flash floods in the last 30 years. The risk zone, encompassing rivers and flash floods, endangers ca. 32,000 residents, with 750-1,800 traditional nomadic dwellings (gers) located on the floodplain of the Buyant River during summer. Furthermore, prolonged rains pose a flash flood risk to households in the center of the province. However, different disaster prevention measures are required compared to those for river flooding in humid regions such as Japan and Southeast Asian countries. In Khovd, residential areas are limited, and land use is not highly dense. In addition, since flood water levels are not high, knowledge of the location and direction of flood flow paths and places where water is likely to be collected in advance is essential for disaster risk reduction. Under these conditions, mapping using detailed DEM and identifying the extent of past floods using satellite images are important. We measured by Real-Time Kinematic (RTK) on 22 Ground Control Points GCPs and collected 15,206 aerial photos for drone mapping under Unmanned Aerial Vehicle (UAV) in the Khovd City. The purpose of this paper is to use Khovd as an example to create a hazard map based on topographical analysis of detailed DEM, and to discuss a methodology for using this map to help with flood disaster prevention in remote areas. The resulting flood hazard map revealed 4 flood risk areas based on flood flow direction and topographical features.*

1.2. Further, the areas at risk are not specified or classified, which would be of interest to decision-makers, and first responders, and support the adaption process.

Using topographical and surface flow direction maps (Figure 4), areas at risk of flooding are identified and explained in Section 5.1 with Figure 9.

1.3. I would advise you to continue and expand your analysis, because it seems, that additional data and information are available, but were not used.

Changes have been made to this manuscript and are marked in red.

Specific comments:

1.4. An evaluation scheme for the risk areas including classification would be helpful to clarify the identified risk areas.

In the 4th section of the manuscript, when determining flood risk areas, the risk areas were identified as a result of analysis of topographic condition and flow direction analysis and geomorphic profiles. Therefore we checked the risk areas on the places.

1.5. As further field data exist (geological, morphological, hydrological?, maybe critical infrastructure?), I recommend conducting further analysis.

1.6. Could the study benefit from evaluating and including the local interviews (shown in Figure 2)? If not, please explain, why the locations of interviews are shown in Figure 2.

We collected questionnaires from 54 local residents during the field mapping study and double-checked flood risk areas. Added a small sentence about it on 3.1.section. It Included:

In addition, during the field mapping step, the flood hazard areas were checked under questionnaires from local residents.

1.7. Would a multi-hazard evaluation be possible, which includes reconstructed or modelled fluvial inundation?

It is good to think about it

1.8. Line 135ff: it is unclear to me, when the Alos Palsar DEM satellite data and when the UAV-generated DEM was used in your study, or how you combined the two DEMs

You're right, the Alos Palsar DEM was not used in this study to a particularly high importance, so the all means was removed about Alos Palsar DEM from the manuscript altogether. It was my mistake sorry.

1.9. Line 174: is it possible to show the alluvial fan on a map?

We can see on the Figure 1 c, d, e, Figure 2 d and Figure 9

1.10. Line 180: please specify "relatively slow"; e.g., please add significant values

Changed the word

1.11. Figure 4: could you additionally show inundation depths?

In the semi-arid region like Khovd, where the risk of flooding increases due to global warming, it is necessary to quickly identify areas where water is likely to collect due to topographical factors and notify residents of the risk. The inundation depth is generally not large, about several tens of centimeters. In humid regions, flood hazard maps that clarify the inundation depth through runoff analysis simulations are useful, houwever creating such hazard maps requires both budget and time. The purpose of this paper is to propose a simple preliminary flood hazard map creation method in such an urgent situation.

1.12. Line 190: how is the grouping of the cells done, and for what purpose?

In detailing the DEM we created from the drone mapping and aerial images , we calculated the percentage of each cell showing its own flow direction into the atribute database on GIS. This is important in determining where surface runoff may accumulate and pose a hazard.

1.13. Is the bed or the water surface area of ditches and rivers shown in the DEM? If not, does the study benefit from embossing the bed level to the DEM?

Yes, we showed the drainage ditch and river in the DEM as Figure 2 and Figure 9.

1.14. How are flow directions further evaluated to overall evaluate the risk posed by flash floods?

Additional information on this is provided in Section 3.3 by red colour

To analyze flow direction, we employed the "Eight Direction Pour Point Model," resulting in the creation of flood hazard maps for Khovd City. The flow method necessitates two high-resolution topographic datasets – a flow direction map and a surface elevation map – at the same resolution to generate a lower-resolved river network map and supplementary maps of river network parameters (Yamazaki et al., 2009). The eight-direction (D8) flow direction coding was applied by considering that the stream flows from the center cell to its eight neighboring cells, and assigning a number to each of the eight neighboring cells based on the direction of flow. For an input D8 flow direction raster, a cell is considered to have an *undefined flow direction if its value in the flow direction raster is anything other than 1 (eastward), 2 (southeastward), 4 (southward), 8 (southwestward), 16 (westward), 32 (northwestward), 64 (northward), or 128 (northeastward) . Output cells with a high flow accumulation are areas of concentrated flow and can be used to identify stream channels.*

1.15. 98-105: please consider moving the background information to the introduction/background

Yes sure, it moved to the introduction/background

1.15. Line 147-171: please move to the description of the study area

Yes sure, it moved to the the study area

1.16. Lines 201-204: please consider moving the background information to the introduction/background

1.17. Lines 212-223: Please provide further information on the sedimentological data you mention (methods, results, consideration in the study). The section belongs to the discussion. Please provide the climatologic data, you are referring to.

1.18. Lines 225 to 242 & 246-253: The section covers parts, that belong to the introduction, study area, and discussion. Please provide the corresponding results, and move sections.

In this manuscript, I wanted to provide an understanding of the risk of flash floods in the dry valley and gullies of Khovd city and the flood risk of the Buyant River. These 2 flood conditions are separate understands and conditions. In other words, this city is located in the middle of the flash flood condition and the river flood condition.

1.19. Line 268: it is unclear how areas were determined. What are uncertainties? How much higher is the risk compared to other areas?

Changed the sentence

*Based on the results of this study, we created a flood hazard map using the information on topographical conditions, flow direction, residential settlements area distribution of households, and previously flooded areas and identified four hazardous and vulnerable areas within Khovd City (**Error! Reference source not found.**) including*:

1.20. Fig 9: how does the hazardous flow direction differ from the general flow direction?

We wanted to show the local residents that there is a possibility of flooding in this area and accumulation in the depressions in by hazardous flow direction. In the 4 areas shown in Figure 9, many householders have been affected by floods in recent years.

1.21. Recommendations are too general. Please link them more closely to your results

Yes sure, we added new sentences in 5.2 section as below:

Geomorphological hazard mapping of this area can alert residents to potential unknown risks. Specifically, it solves the following problems: 1) Because the area is semi-arid and there is no running water, residents do not recognize the risk of flooding. 2) Because the terrain is generally flat, residents do not know where the water will flow during floods. 3) After an artificial embankment was built in the 1990s, the flood flow path changed, but residents cannot predict what will happen if the embankment breaks. 4) The Buyant River flows at a low level on the west side of the city, but the residents of Khovd have never experienced floods there historically, so they are completely unaware of the risk of flooding.

Technical corrections:

1.22. Could you please specify the unpublished literature (e.g., cite the publications as “under review”, if applicable)

Corrected

1.23. Figure 1: Location of pictures is not marked on the map

We provided figure’s explains, is it necessary to mark on the map?

1.24. Line 80 ff: km2 must be km²

Corrected

1.25. Line 91: please check the line break at the end.

Corrected

1.26. Figure 2: Please change /xx/ to (xx)

Corrected

1.27. Table 1: the information seems a bit excessive. Could you remove parts of it, by referring to the UAV you used?

Which one to exclude?

1.28. Line 141: Hiishade must be Hillshire

Corrected …Hillshade

1.29. Line 141 ff: (Fill-Flow-direction-Flow accumulation-Stream order-Flow length-Watershed-Basin-Snap pour point and others) commas are missing

Corrected

1.30. Figure 5 and Figure 7: the dashed red line is missing in the legend

Added explain sentence in the figure desription

The red dashed line shows the profile slope.