Reply to anonymous referee #1

We thank the reviewer for her/his constructive comments. Below we give detailed replies and outline the changes made to the manuscript.

Specific comments

a) *Newspaper often mix up the terms bedload transport and debris flow. Therefore the key words would be very interesting.*

We agree and the distinction between bedload transport and debris flows was in fact a tricky part of our preliminary work. We tried to improve the text to explain how we proceeded, see point (b) below. We also decided to compile a table that should be added at the end of our article in form of supplementary material. This table comprises all keywords we used to carry out the search (within the description field of the 19'013 original database entries) and thus to reduce our working database to 5517 entries. As the Swiss flood and landslide damage database is in German, the keywords are, too. In our supplementary table, we list the keywords in German and added an English translation.

b) *How do you distinguish between fluvial bedload transport and debris flow?*

We added a paragraph in the methods sub-section 2.2 in which we provide information on our approach. It is important to stress that the decision whether a damage event was caused by bedload transport or a debris flow (or whether bedload transport was partly involved in the damage process) is based on the event description (description field) within the original Swiss flood and landslide database. Note that we did not differentiate between the processes of debris flow or bedload transport based on the topological parameters later derived for the discussion in section 4.2 (these parameters were only determined for municipalities and regions and not for catchments). However, in the separate screening of database entries we did use available photo coverage, maps and expert/local knowledge for process differentiation.

In the supplementary material at the end of the article, we added a fictive example of a single data entry in an additional figure. This auxiliary figure will help the reader understand how damage processes were identified and defined within this contribution.

c) *How did you decide whether bedload transport played a major role?*

This is a good point. We assume the reviewer refers to the statement we make at page 4187, lines 2-4 ("During this process, for each entry we had to decide whether fluvial bedload deposition or erosion played a substantial role in the damage symptoms or not"). Actually the adjective "substantial" is out of place here, because we screened the 5517 data entries looking for any reference of bedload processes as cause of the resulting damage. Damage costs induced by bedload transport processes were then estimated in a next step. We thus replaced "a substantial" by "any".

d) *Maybe characteristic numbers (e.g. Melton ratio) could help to distinguish between the processes?*

The differentiation between hazard processes (debris flows or fluvial bedload transport) in our study is not based on characteristics like slope etc. It is based on the event description (see above, reply b). A differentiation as suggested here would only be possible if we were able to assign hydrological catchments

to our damage locations. However, for our database it is often impossible to derive the exact hydrological catchment associated to a given bedload damage point. We explicitly address the possibility to use the Melton ratio for our study areas in our reply to comment (d) of referee no. 3.

e) How was the mean channel slope calculated? Mean values higher than 25 % indicate very steep (sub)-catchments. These sub-catchments could transport the sediment as debris-flow. They indicate the relief energy required to deliver sediment to the streams. The local (mean over a certain length) channel gradient at the location of the damage would be interesting for further analysis.

Mean channel slope was calculated for municipalities and regions, but not for specific stream catchments (the reason for this approach is explained below). The method adopted for the calculation of mean channel slope is explained in section 2.4: "Channel bed gradients were calculated with standard flow routing algorithms for all grid cells defined as a stream-cell [within a municipality or region], i.e. that drain a hydrological catchment with an area of at least 0.1 km^2". Then, we calculated the mean gradient for municipalities and subareas using the single grid cell values.

A main problem within our study is the fact that the spatial information comprised in a single database entry of the flood and landslide database is generally quite inaccurate. This is because the coordinates given for every database entry are normally referring to the location of the main damage that occurred during an event, which is not necessarily identical with the point along a stream where bedload transport first took place. Quite often, however, the basic information (derived from the media reports) is not accurate enough to pinpoint the center of damage, or even the channel which was active. In such cases we only know in which political municipality the damage occurred. As a consequence, the hydrological catchment associated with the flood generation (leading to a bedload transport event) can rarely be defined (cf. the response to comment (d) of reviewer no. 3). Likewise, it is hardly practicable to determine the local channel gradient at the location of bedload transport damage occurrence for 3588 database entries. We added a paragraph to the manuscript (section 2.3) that describes this problem and explains why we had to carry out our analysis of controls on bedload damage costs at the municipal and regional level.

Regarding the very high mean values we obtained (> 25 %) that indicate steep channels within municipalities/subareas, we would like to stress that they represent characteristic values we derived to be able to compare between different areas. They are high because they include first order channels. By altering the calculation procedure (e.g., use of a threshold value larger than 0.1 km^2), lower values could be obtained for all subareas/municipalities.

<u>Technical corrections</u>

Table 1. The %-values (numbers of municipalities affected) are given as proportion (e.g. 0.26 instead of 26%).

We changed all the data in the ninth column of Table 1 from ratios to percentage values.