Dear Paolo,
We would like to express our sincere thanks for your thorough review and the constructive comments on our manuscript. We are happy that you rated the results to be interesting and relevant, and that you suggest the work to be considered for publication in HESS.
Your comments were very helpful for further improving our paper, please find below our reply to each specific remark. Where appropriate, we added some discussion on the items.

Comment:
1. Introduction
a. More references and in-depth bibliographic analysis are needed with respect to the concept of (flood) risk (page 2, row 23; page 3, row 6), in particular when it comes to its formalization as a function of different clusters and dimension of analysis (hazard, exposure, vulnerability, from an social, economic, environmental viewpoints?) and its practical "application" in the framework of the European Flood Directive, among the others.

Reply:
In agreement with the reviewers suggestion we added references at page 2, row 23 and page 3, row 6. We think that now the bibliographic analysis is more comprehensive.
The text now reads:
The concept of risk had been introduced in order to manage the resulting challenges, with respect to temporal and spatial dynamics of social (de Vries, 2007, Cutter and Finch, 2008) and engineering dimensions (Kienholz et al., 2004; Fuchs et al., 2013).

Comment:
1. Introduction
b. Page 4, rows 5-6: which typological classes of buildings are you referring to? Please specify.

Reply:
We substituted the term building with the contextually more fitting and more general term "structure". In this case we refer to the general field of fluid structure interaction modeling, which considers the coupling of hydrodynamics and deformation behavior of the structure. Studies focus on beams plates and shells in a flow field and not on more complex structures like residential buildings.

Comment:
1. Introduction
c. Page 6, rows 11-12 and 17 to 19 (and more on page 17, rows 1 to 7): the definition of the "serviceability" is not clear, in particular (suggestion): why do not you consider also the loss of service of the facilities (electricity, water, power supply) in the characterization of the SLS of the building, since you suggest to include in the design situations to be considered also the "comfort of people"?

Reply:
In the paper we use the serviceability concept in adherence to the EN 1990 norms for the technical usability of buildings. This concept refers to conditions under which a building is still considered to be used for its original purpose. Should these limit states be exceeded, a structure that may still be structurally integer, while being unusable.
Serviceability limit state design of structures includes factors such as durability, overall stability, fire resistance, deflection, cracking and excessive vibration.
Moreover, at the current stage of research, we decided to accurately model the impacts on the building envelope and to infer "indirectly" consequences in the interior volumes of the building.
For the pure water flood case we also simulated with a 3D model the flow behavior within a complex building. This degree of detail would allow for precise considerations regarding the loss of service of the facilities (electricity, water, power supply).
Unfortunately for the debris flow case, to our knowledge, numerical models are not capable to reproduce the 3D flow field satisfactorily. Currently we are considering introducing, in addition to the damage

susceptibility profile, the loss profile, where taking into consideration expert knowledge the consequences for the functional systems are assessed in detail (comparing scheme shown in Figure 1).

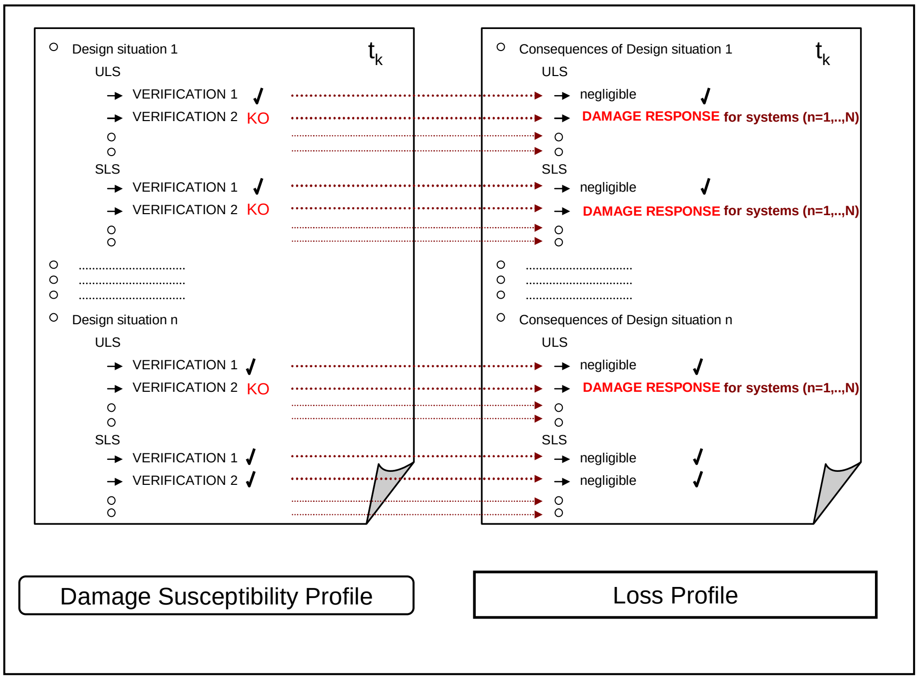

Figure 1: Damage susceptibility profile and loss profile

To conclude, we fully acknowledge the suggestions of the reviewer and we will approach with rigor these issues in the near future.

Comment:
1. Introduction
d. Page 7, rows 1 to 3: you stated: “we will discuss the added value of the presented methodological approach for the planning of both functionally and economically efficient local structural measures as a complement to conventional mitigation strategies”, but this does not appear both along the text and the conclusions as well. Please add some comments on this.

Reply:
We added the following string in the conclusions:
Understanding, identifying and quantifying vulnerability is an essential need for designing and implementing effective and efficient flood risk mitigation strategies in general and local protection measures in particular. The proposed damage susceptibility concept is a useful entry point for the planning process. It highlights the verifications that have to be met by the design of local protection measures.

Comment:
2.3.2. Fluid flow impacts relevant for structural and physical responses analysis a. Page 12, row 6 and follows: what is the difference between the “confined and unconfined flow”? Is the confined flow situation the most frequent one in mountain environment? If so, is there any reason to prefer the use of the unconfined flow formula provided by Eq. (1) in the formalization of pDFD and pDFT (page 13, row 19)?

Reply:
Instead of confined and unconfined flow we could write channel and overland flow. So, on an alluvial fan, overland (unconfined) flow is the relevant flow type to be considered when it comes to channel outbursts. Consequently the unconfined formula is preferred. The formula for confined flow has been derived from theoretical and experimental flume tests. The flume was an inclined rectangular shaped channel and featured a vertical wall over the entire flow section (compare Odorizzi et al., 2009). Debris flow surges impacted on

the wall but were prevented to flow around the obstacle with the net effect of a total reflection at the wall (with different mechanisms). This setting is really uncommon for buildings located on an alluvial fan.

Comment:
a. You provide the reference of Suda et al. (2012) for the Eq. (2) but the paper is in german. Is any English reference available?

Reply:
We added a comparable English reference.

Comment:
c. Page 13, row 11 to 20: please use the bullet-points structure to detail the definition of the variables.

Reply:
We modified the structure according to the reviewer's suggestion.

Comment:
2.4 Structural and physical response analysis
a. page 17, rows 7 to 13: It seems that there is a repetition of concepts, please check.

Reply:
By dropping "where Ed is the design value of the effects of actions in the dimension of the adopted serviceability criterion and Cd is the design value of the upper limit for the adopted serviceability criterion" we avoided in the revised version of the manuscript possible repetitions of concepts.

Comment:
b. Page 18, rows 2-3: No accurate arguments are provided for the exclusion of SLS from the analysis. Please specify.

Reply:
We agree with the reviewer that for completeness SLS should not be excluded from the analysis. In our opinion the relevance of both ULS and NLS is undisputable for the generation of direct damages. Therefore we deserved particular attention to these damage generating mechanisms.
We modified the text from "Focusing on the essential, we consider only the ULS and the NLS" to "Since the relevance of both ULS and NLS is undisputable for the generation of direct damages, these limit states are considered in our analytic setup"

Comment:
c. Page 18, row5: Fig.6 does not provide any additional information to the concepts clearly expressed in the texts and therefore it can be avoided.

Reply:
We agree with the reviewer and deleted this Figure in the revised version.

Comment:
d. Page 18, row 6: Eq. (11) is not present, please check.

Reply:
In fact Equation 11 is not present, since the compactness of the last formulation of Eq 10 made Eq 11 superfluous. In the revised version this reference has been cancelled.

Comment:
e. Page 18, rows 9-10: the sentence is not clear and no arguments to prove the suitability of the methods adopted are provided. Please specify.

Reply:

We changed the strings from
“The representation of damage responses in form of deterministic event chains or stochastic event trees is particularly suitable. In the latter case, subjective probability assignments to hypothesized damage outcome events have to be considered.”
to
“The proposed analytic setup allows for a comprehensive description of the damage response behavior of the building envelope. Since the flow process through the building is not simulated, an expert based derivation of stochastic event trees might be helpful to hypothesize the full range of possible damage consequences of the considered building. In this case, however, subjective probability assignments are necessary.”
We are convinced that through this formulation the contents are more clearly conveyed to the reader.

Comment:
3.1.1 Process analysis
a. Page 20, rows 11 to 14: The role of the various models used (Armanini, Rosatti and Rigon) in computing the solid transport component represented in Fig. 10 as well as the interaction with the debris flow component. Please specify.

Reply:
In this part of the text we described how the boundary conditions for the application of the debris flow propagation models have been derived by a back analysis combining the results (i.e. liquid hydrograph) of the application of the hydrological model (Rigon et al., 2011) and the evidences of the event documentation (i.e. deposited volumes). So this step refers to the derivation of the input parameters for the application of the debris flow propagation model (Armanini et al, 2011 and Rosatti et al., 2013).
The paragraph was rephrased to
“Hydrological and hydrodynamics modeling was undertaken with the purpose of quantifying static and dynamic loading impact of the debris flow on the target building and their evolution in space and time. In particular, for this specific event, flow velocities, flow heights and deposit thickness were computed and compared to measured values. Patterns of deposits were measured by intensive field surveys carried out by the Hydraulic Engineering Department of Bolzano few days after the event and used for model calibration. The computational 2-D domain was chosen with the purpose of focusing on the spreading of the debris flow along the fan, i.e. downstream the slit dam. An additional rational for this choice was that the patterns of deposition and the total volume deposited on the fan were known. The total volume was estimated to be 53 000 m3. Boundary conditions were given in terms of liquid and solid hydrograph; the liquid hydrograph was derived using a back-analysis approach aiming at reproducing field observations, i.e. the event duration (roughly 6 h, Fig. 10) and the total amount of transported sediment (flow transport capacity). The liquid boundary condition was computed using a geomorphologic, semi-distributed hydrological model (Rigon et al., 2011) which accounts for different residence times characterizing various portions of the watershed. The rainfall input to the model was derived from measured rainfall data. Solid inflow boundary conditions were calculated on the basis of the stream bed gradient, the average characteristic of the transported sediments (internal friction angle, d50) and the liquid hydrograph.”

Comment:
b. Page 21, rows 1 to 6: it is not clear the positioning of the various sides of the building with respect to the (observed) debris flow. I believe that one figure could help on this.

Reply:
We provided two new Figures in the revised version.

Comment:
3.3 Structural and physical response analysis
a. Page 22, row 10 to 12: it is not clear the reason to exclude the ECU limit state from the analysis. Please add some more arguments.

Reply:

In our experience with debris flows, the ECU limit state is always verified provided that geo-mechanical mechanisms do not intervene (particularly slippery strata below the foundation or scouring). Structural failures of the building envelope are by far more likely.

Comment:
b. Page 22, rows 26.27: you stated that “simple exposure to wetting is not critical for the considered building” but no arguments to support this sentence are provided and from the comparison with Eq. (10) and Table 2 does not clarify this aspect. Please specify.

Reply:
Material intrusion is the critical phenomenon. In case of debris flows the event durations are rather short compared to lowland river floods, where exposure to wetting might become relevant, particularly for building featuring expensive external insulation panels.
The process of moisture content though the building walls are limited and the effects can be neglected.
We added some sentences in the manuscript.

Comment:
4. Discussion
As already affirmed, the method you provided seems to be reasonably robust and applicable to a wide range of case studies, but it has been conceived and validated for debris flows, and comparable natural hazards only. Some more consideration for its application to “water floods” situations are needed, in order to justify the title of the paper too.

Reply:
In our opinion the overall approach presented is generally applicable for a broad range of hydrological hazards, and we are convinced that the debris flow case is, due to its complexities, capable to represent also most of the difficulties of pure water flows.
Floods in urban environments however might exhibit particular and mostly indirect damage generation mechanisms (i.e. pluvial flooding mechanisms, back water in drainage systems and hydraulic pipe systems of the building). These peculiarities merit a particular focus. We suggest investigating such vulnerability effects of these systems separately. Our current research efforts are devoted to such problem settings.