Response to review, second revision round – review 1

The review comments are marked in blue, our response in black.

With regard to river bed elevation, you state in your response that this will not have an effect on your result, as you are not investigating low flows. Can you state a range of depths that the channel is expected to vary? That is, are the non-flood channels only a few cm deep, so that the flood depth is much greater than the non-flood channel depth? Or are they similar order of magnitude? I'd expect that channel depth has a large effect on the transit time of the flood wave, as well as the diffusion of the flood wave. Therefore, I do not agree with the authors' reply that channel depth is irrelevant, and I still think a sensitivity analysis should be carried out. The authors' other response that depth is irrelevant because the downstream boundary condition is normal depth, is only applicable for steady flow conditions, not unsteady flow, so I don't think that answers the question.

Under normal flow conditions the channel depths are in the range of 50 cm at the two gauges in the studied river reach. The estimated flow depth of the 2-year event is 85 cm at both gauges (Altenahr and Bad Bodendorf). In this upper part of the reach with a deeply incised river into steep hills, the depth of 85 cm is an order of magnitude lower than the flow depths observed during the flood event, which reached depths of 8 – 12 m. In the lower part of the reach the flow depths are lower, but still in the range of 4 – 6 m, thus still much larger than the flow depth of the 2-year flood, almost an order of magnitude. This is the basis of our argument, that the neglected river bed has little effect on the simulation of the overall flood extent and floodplain inundation depths.

In order to show the effect of the neglected river bed, we corrected the DEM cells identified as river bed. We hereby conservatively assume that the LiDAR DEM refers to flow depths of the 2-year flood, i.e. bankfull discharge. Thus, we lowered the DEM of the river bed by 85 cm and repeated the simulation to show the effect of the neglected river bed. The obtained results differ only marginally from the results obtained with the original model version. Figure 1 shows the difference in maximum inundation depths, and Figure 2 shows the difference in maximum flow velocities. It can be seen that the differences in water depths are mainly in the range of -0.1 to 0.1 m, and the differences in flow velocities are in the same range in m/s. This is also illustrated by the bottom right histogram in Figure 3 showing the cell-wise differences of the maximum inundation depths. Larger differences occur, as expected, in the identified river bed of the DEM. However, the floodplain inundation depths and flow velocities, as well as the inundation extent are practically identical. This is also expressed in the almost identical model performances listed in Table 1, comparing the observed inundation extent with the simulated by the Critical Success Index CSI, and the performance in simulating inundation depths by comparing the 75 reported flood marks with the maximum inundation depths (Bias and RMSE). It has to be noted that the performance values slightly modified compared to the manuscript, due to an error in projection of the shape file showing the locations of the water marks, which was used for extracting the water depths at the locations of the water masks from the simulation results.

Overall, the simulation of the flood with a lowered river bed, that is assumed to approximately match the actual one, produces almost the same results in terms of floodplain inundation depths and flow velocities. This shows that the model and the modelling approach is valid and fit for the purpose, i.e. modelling extreme floods and floodplain flow with simplified bed representation as given by the DEM.

In order to show this proof of the model concept we propose to include the additional simulation and the analysis of the results with a lowered river bed in a supplement to the manuscript, and refer to it in the manuscript itself.

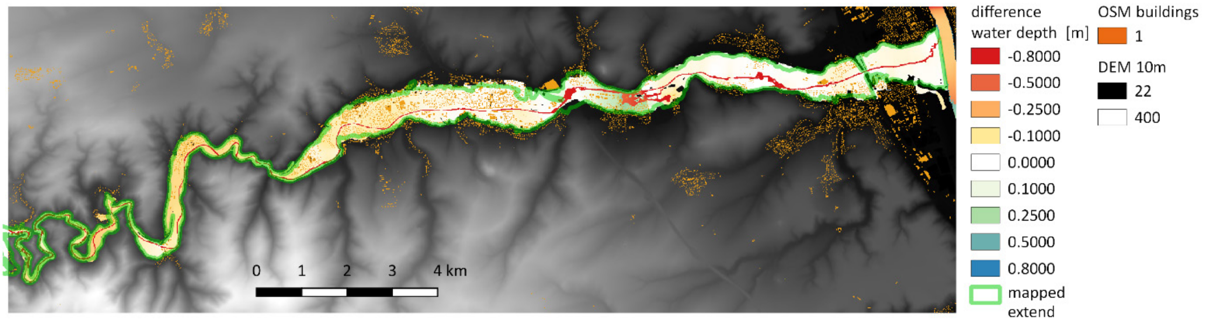

Figure 1: Difference of maximum water depths original simulation minus simulation with lowered river bed.

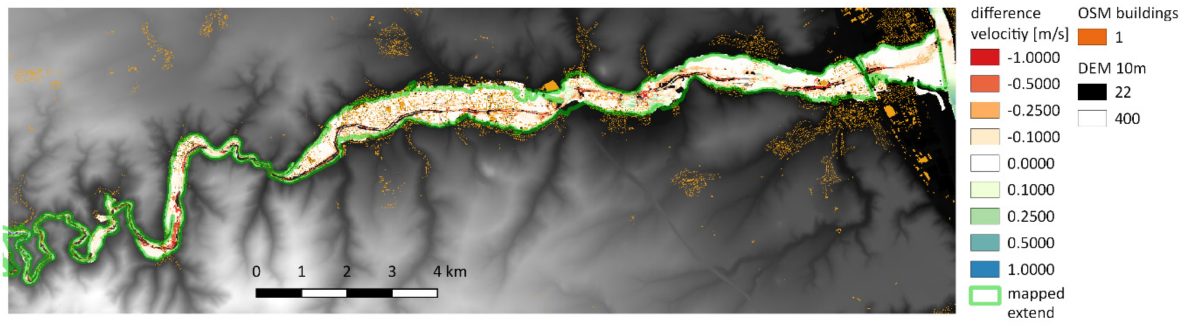

Figure 2 Difference of maximum flow velocities original simulation minus simulation with lowered river bed.

model	**flooded area [m2]**	**CSI**	**Bias [m] (obs. - sim.)**	**RMSE [m]**
original DEM 10m	12369300	0.843	-0.39	0.66
modified river bed -0.85m	12399200	0.842	-0.41	0.68
forest roughness n = 0.1	12375600	0.843	-0.4	0.67
forest roughness n = 0.2	12384100	0.842	-0.41	0.68
forest roughness n = 0.3	12384100	0.842	-0.42	0.68
forest roughness n = 0.4	12384800	0.843	-0.42	0.68
forest roughness n = 0.5	12384600	0.843	-0.42	0.68

About Manning's n, indeed LisFlood has been applied to many situations and locations. However, those other studies do not indicate whether your own study has been applied correctly. You should either do a sensitivity analysis to the roughness values you choose, or use land-use-dependent tabulated values that are generally accepted by the modeling community. Without doing so, there is little reason to have confidence in your result. Again, part of the reason for this is because your value for forest of n=0.05 is very small compared to those listed in Chow (1959) and Arcement & Schneider (1984) of up to n=0.2 for forests and urban areas.

To start the discussion about the roughness parameterization we want to point out that the roughness in simplified hydraulic models has to be seen as an effective parameter, that compensates for model structure simplifications, rather than a “generic and extrapolable physical interpretation” of surface roughness (de Almeida and Bates, 2013). Moreover, the roughness values listed in e.g. Arcement and Schneider (1989) or in the old text books of Ven Te Chow refer to either channel flow, or to 1D simulations of floodplain inundation. In this context it was also necessary to compensate the model deficiencies in simulating 2D flow over complex terrain by adjusting the roughness. The cited high value of n = 0.2 for urban areas is an example for this, because the flow resistance caused by the urban fabric could not be considered explicitly by the models and had to compensated by a higher roughness. This concept was then extended to (coarse) 2D modelling, in which the urban fabric was also not considered explicitly, but by a higher roughness ("urban porosity"). However, in this study the urban fabric is considered in detail, and the model simulates the flow around buildings on streets. Thus, the low roughness of n = 0.02 for flow over tarmac and concrete was used. Using a high value of n = 0.2 would be contradictory to the modelling approach.

For forests the comparatively low value of n = 0.05 was chosen, because the forests in the area are mainly spruce monocultures with practically no undergrowth. We regarded this type of forest to have a hydraulic roughness not much higher than a normal meadow. Moreover, the forest areas are to a vast extent outside the flooded area, thus not relevant for the inundation simulation. The forest roughness was thus not be seen as critical for the simulation results.

But in order to show this, we conducted additional simulations setting the forest roughness to n = 0.1, 0.2, 0.3, 0.4, and 0.5 respectively. As expected from the rational outlined above, the simulation results hardly changed at all. This is expressed in terms of the practically identical performance measures of the models listed in Table 1, and the histograms of the differences to the original simulation in maximum inundation depths per cell shown in Figure 3. Minor changes occur, because just upstream of the town of Bad Neuenahr-Ahrweiler an area in the floodplain of about 0.15 km^2 is classified as forest. These results show that the model reacts to changes in roughness, but in this particular case the question of roughness parameterization of forest does not play a major role. However, in order to avoid similar questions and discussions we will use the simulations with n = 0.2 for forest in the revised manuscript.

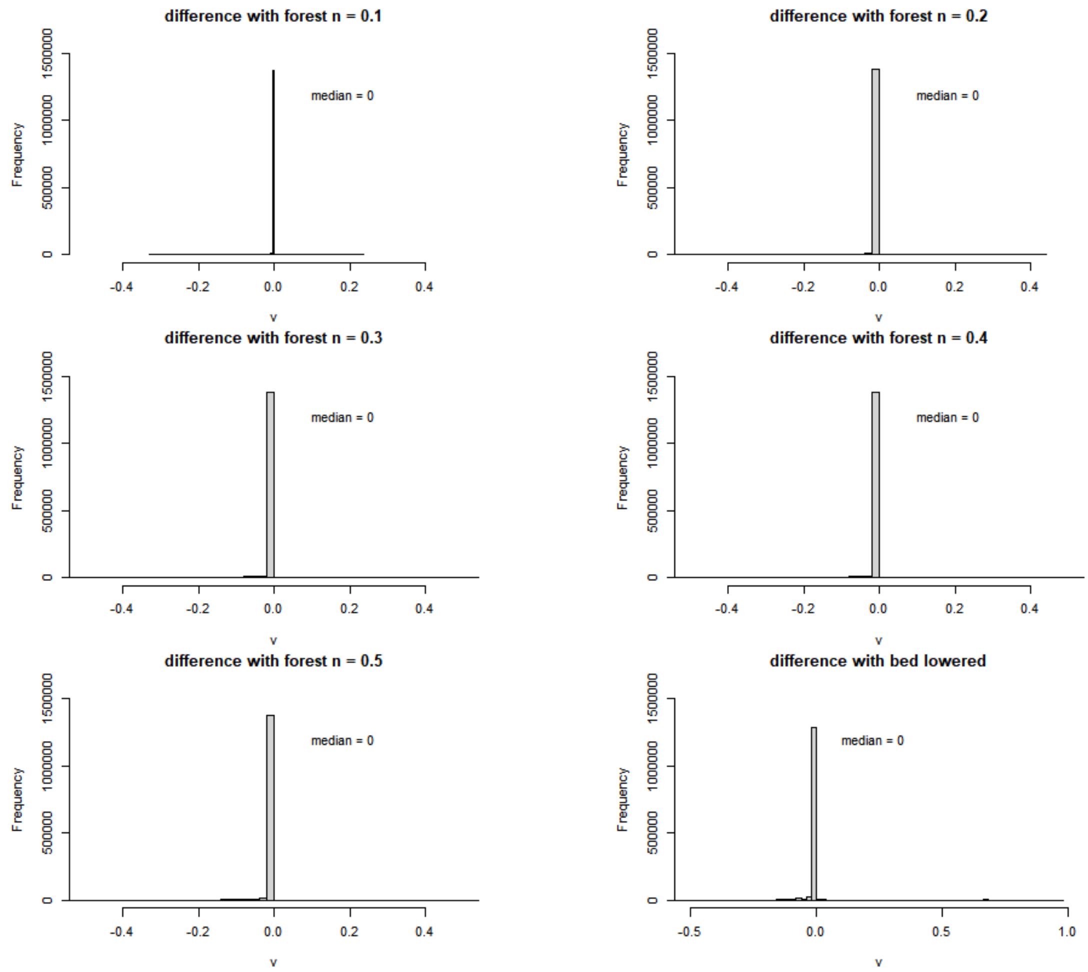

Figure 3: Histograms showing the difference of the simulations using different roughness values n for forest areas, and with a lowered river bed (bottom right) to the original simulation based on the unmodified DEM and forest roughness of n = 0.05.

About human and vehicle instability, it's probably better that you remove the whole discussion, if you are just going to apply one equation and show the results, as this produces little useful knowledge. Just my opinion, but it seems like useful knowledge could be gained by comparing multiple methods, even if this expands your paper into a full paper rather than a short note.

We disagree in this point. What we want to show with this brief communication is that impact forecasting for a better informed and actionable flood disaster management is possible with the methods and models developed by many researchers in the past years. The map showing the hazard for humans to drown serves as an example, as well as the cited literature for car instability and structural building failure. The purpose is not to discuss the pro's and con's of the different published approaches for these flood impact categories. This was already done in the cited studies on the individual flood impact models, and the use of a particular model has to be decided if these approaches are eventually adopted in operational flood forecasts. The message here is: it is possible, and it adds to a better informed and actionable flood impact forecast.

However, we cite additional studies on human instability in the revised manuscript to show the different studies and models available for this impact category. Citing only a single study is admittedly biased and needs to be corrected. The additional references added are (Jonkman et al., 2008;Milanesi et al., 2015;Penning-Rowsell et al., 2005;REDSCAM, 2000).

References

Arcement, G. J., and Schneider, V. R.: Guide for selecting Manning's roughness coefficients for natural channels and flood plains, Report 2339, 1989.
de Almeida, G. A. M., and Bates, P.: Applicability of the local inertial approximation of the shallow water equations to flood modeling, Water Resources Research, 49, 4833-4844, 10.1002/wrcr.20366, 2013.
Jonkman, S., Vrijling, J., and Vrouwenvelder, A.: Methods for the estimation of loss of life due to floods: a literature review and a proposal for a new method, Natural Hazards, 46, 353-389, 2008.
Milanesi, L., Pilotti, M., and Ranzi, R.: A conceptual model of people's vulnerability to floods, Water Resources Research, 51, 182-197, 10.1002/2014WR016172, 2015.
Penning-Rowsell, E., Floyd, P., Ramsbottom, D., and Surendran, S.: Estimating Injury and Loss of Life in Floods: A Deterministic Framework, Natural Hazards, 36, 43-64, 2005.
REDSCAM: The use of physical models in dam-break analysis, Helsinki University of Technology, Helsinki, 56, 2000.