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Brief communication: Impact forecasting could substantially improve the emergency management of deadly floods: case study July 2021 floods in Germany

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Supplement S1 – Influence of neglected river bed bathymetry on flood simulation

In order to show the effect of the neglected river bed, we corrected the DEM cells identified as river bed (initially wet cells obtained by the steady state flow simulations). We hereby conservatively assume that the LiDAR DEM river bed, i.e. water surface, shows flow depths of the 2-year flood which typically corresponds to the bankfull discharge. These are estimated to 0.85 m at both gauges in the river reach (Altenahr and Bad Bodendorf). Thus, we lowered the DEM of the model river bed uniformly by 0.85 m and repeated the simulation with the same model setup in order 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 S1 shows the difference in maximum inundation depths, and Figure S2 the difference in maximum flow velocities. It can be seen that the differences in water depths outside the rived bed are 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 histogram in Figure S3 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 S1, 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).

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.

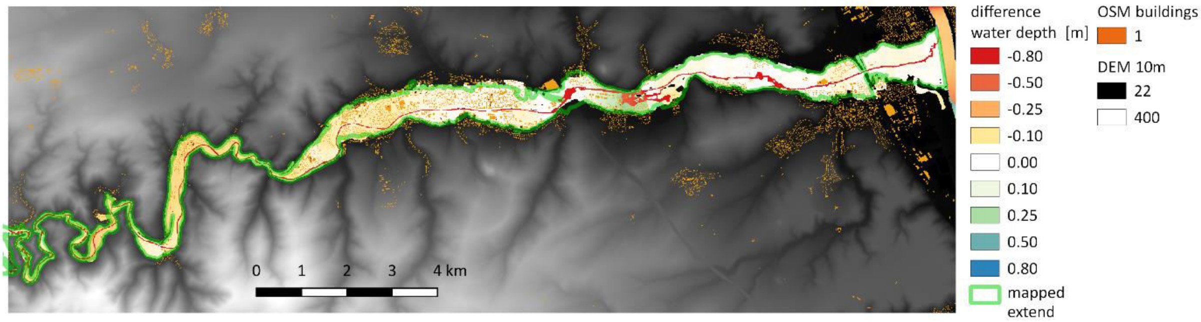

Figure S1: Difference of maximum water depths original simulation minus simulation with lowered river bed.

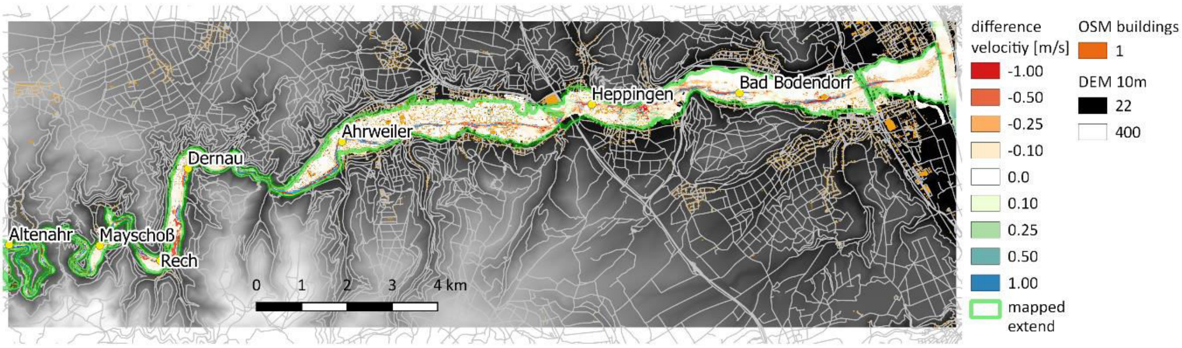

Figure S2: Difference of maximum flow velocities original simulation minus simulation with lowered river bed.

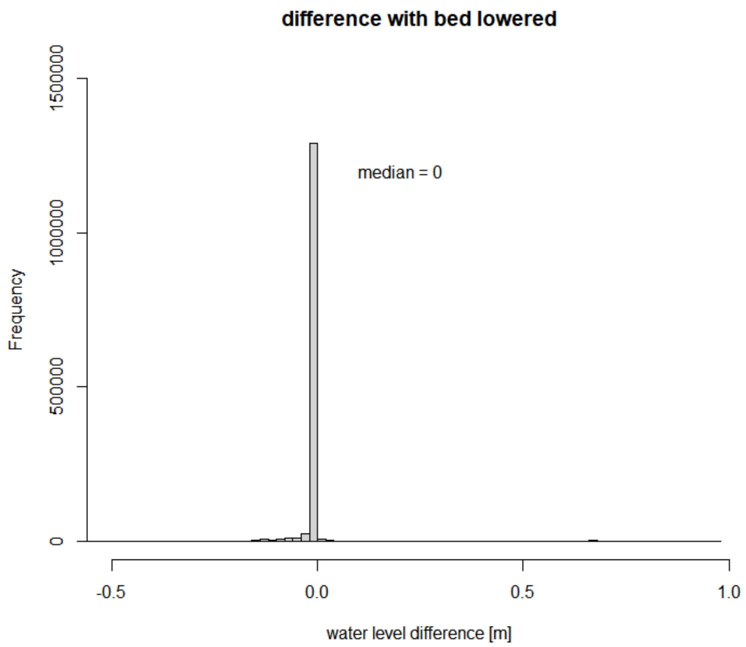

Figure S3: Histogram showing the difference in maximum inundation depths to the original simulation based on the unmodified DEM and the DEM with the model rived bed cells lowered by 0.85 m.

Table S1: Performance measures of the simulation with the original DEM and the lowered bed elevation

model	flooded area [m^2]	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