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Hydrology and Earth System Sciences Discussions

Interactive comment on "A method for parameterising roughness and topographic sub-grid scale effects in hydraulic modelling from LiDAR data" *by* A. Casas et al.

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This is an interesting and well-written paper investigating the utility of airborne scanning laser altimetry (LiDAR) for providing a 1D – 2D river flood inundation model with spatially distributed floodplain topography for model bathymetry, together with vegetation heights for parameterisation of distributed model floodplain friction. Only modest modification and some clarification is required. LiDAR ground hits are used to calculate DEMs of different topographic content, while vegetation hits are used to calculate distributed vegetation roughness heights. The latter are used to estimate a flow resistance (roughness parameter) for each model grid cell using a mixing layer theory for submerged and emergent vegetation given vegetation height and flow depth. The theory provides a neat analytical link between roughness and water depth and velocity, though ignores reduced resistance due to bending of vegetation and alignment of foliage with flow at higher velocities (Kouwen and Li 1980; Kouwen and Fathi-Moghadam 2000). The method encapsulates the three-way interaction between the discretised mesh resolution, the topographic content of the DEM and the roughness parameterisation. Subscale roughness parameterisation is shown to influence flood depth and inundation extent.

The importance of the paper lies in the fact that it allows a comparison of a method using a spatially- and temporally-varying floodplain roughness parameterisation with the normal method of treating floodplain friction as a lumped free model parameter which is independent of flow depth and velocity, and which requires calibration (though, as the paper states, it is true that the latter accounts not only for the vegetation impacts on flow but also momentum losses not explicitly accounted for in the model). While a good deal of additional data processing and computation is necessary to estimate distributed roughness and its hydraulic effects, it is important to know the differences in flood depths and inundations between the two approaches.

Possibly the interpretation of the results has been rather hamstrung by the fact that a field survey of ground topography and vegetation heights has not been carried out. On p. 2274 line 10, it is stated that the roughness parameter is sensitive to interactions between the roughness height and topographic content (Fig. 7a). This may be because the LiDAR heights have not been properly separated into ground class (for inclusion into topographic content) and vegetation class (for inclusion in roughness height). The reader is not told the details of how this separation is made. If there were poor separation, the roughness height and hence the roughness parameter should reduce as topographic content is increased. However, it is confusing that this is not apparent in Table 5. It is also strange that, in Fig. 7a, the roughness parameter RMSD between DEMref and DEM±5cm is large compared to that between DEMref and DEM±50cm.

Maybe it would help to plot mean difference also to check if there is a systematic bias. A related point of confusion is that, even if there were no vegetation, there would still be friction due to sub-grid topographic variation (form drag), giving a higher roughness parameter for larger topographic content. This is not reflected in equation (7), which is independent of topographic content unless roughness element height D can contain a component due to this. A separate problem related to the lack of a field survey is that, for the roughness height, an assumption seems to have been made that the LiDAR return is measuring the height of the top of the vegetation, whereas in reality it is probably measuring a point lower in the canopy (Cobby et al. 2001). This would result in the value of roughness height being lower than it should be, underestimating the roughness parameter. The authors should provide clarification and comment on these concerns.

Other minor comments are:

In equation (3), the numerator in the cosh term should be ($1/\alpha - \xi/\alpha$) to make it dimensionless.

Which corner of the rectangle in Fig.1 is the (0, 0) point for Figs. 3 and 5?

2271, line 9: it is confusing that it states that the boundary condition option of velocity downstream and stage upstream was chosen, yet Table 2 gives figures for velocity upstream and depth downstream.

2271, line 13: how does the 2km-long modelled reach relate to that in Fig. 1, which is only about 0.5km long?

2273, line 10: in Table 4, Geary's C seems to increase as larger topographic content is introduced, rather than decrease as stated here.

References:

Cobby, D.M., Mason, D.C. and Davenport, I.J. (2001). Image processing of airborne scanning laser altimetry for improved river flood modelling. ISPRS J. Photogrammetry

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and Remote Sensing, 56, 121-138. Kouwen, N. and Li, R.M. (1980). Biomechanics of vegetative channel linings. Journal of the Hydraulics Division, ASCE, 106(6), 713-728. Kouwen, N. and Fathi-Moghadam, M. (2000). Friction factors for coniferous trees along rivers. Journal of Hydraulics Engineering, ASCE, 126(1), 732-740.

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