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Reduced complexity models of floodplain inundation: how to deal with sub grid scale diffusion

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We now routinely model flood inundation using reduced complexity models. Traditionally, these have involved both depth-averaging and width-averaging the mass and momentum equations for flow. With the advent of more powerful computing capability as well as better boundary condition and geometric data there has been the relaxation of width-averaging. One particular formulation of depth-averaged models has gained particular credence: diffusion wave modeling based upon ignoring the temporal and spatial accelerations in the momentum equation. Strictly, this assumption is only valid when the flow is shallow and the topographic forcing term is dominant. This can be shown to be the case for many floodplain flows. However, it still leaves the problem of discretisation and solution. Results from modeling floodplain inundation for a complex urban environment (the City of York, UK) show that as currently formulated, these diffusion wave models reproduce inundation patterns that are much too sensitive to main river water level fluctuations, resulting in over-estimation of inundation, especially where the floodplain is not laterally confined. This is particularly worrying as the method has been used to derive the 1:1000 year flood outline for the whole of the U.K. Instead, we present and validate an alternative sub-grid formulation that introduces an explicit representation of finer resolution topographic effects and show that this results in a much more realistic representation of inundation extent. It allows us to move away, almost entirely, from having to worry about the right value of Manning's n for floodplain inundation.