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Hydrology and Earth System Sciences Discussions

Interactive comment on "A mass conservative and water storage consistent variable parameterMuskingum-Cunge approach" *by* E. Todini

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Review by Geoff Pegram of paper by Ezio Todini on Variable Parameter Muskingum

The Muskingum model is a staple hydrological river-flow routing model and has been coded into many software packages. Because the K parameter is effectively the time of travel of the centroid of a hydrograph from one end of the river reach to the other and the X (or 'epsilon' in the paper) parameter controls diffusion, so that one can have kinematic flow at one end of the spectrum and storage diffusion effects at the other, it has tremendous physical appeal. Cunge added more flexibility by relating the parameters to channel properties and Manning's formula. The paper addresses a problem which is so subtle, it has been buried in the 'n'th iteration of the model's development and thus hidden from practitioners' eyes; it has taken a person with an iconoclastic mind-set to define the problem and then provide an elegant solution.

I have little to add to the paper that can improve it, but would like to comment on what appears to me to be a popular misconception in applying the Muskingum-Cunge formulae, which appears to be another sort of paradox. My version of the paradox is that, if one takes Cunge's definition of X = (1-D)/2, where D = Q/[B S0 c Dx], then for all other things fixed, as Dx becomes large then X tends to 0.5, implying pure Kinematic flow with no diffusion. This implies that the longer the reach, the lower the diffusion, which is clearly nonsense. The problem stems from the original Muskingum formulations as documented by Linsley et al (1982: 275), where the "river reach" is defined as the distance between the two stations, where hydrographs have been observed and whose properties yield the constant K and X terms.

It would be helpful if the paper emphasized that the Dx used in the Muskingum-Cunge formulation should be limited to the computational spatial interval or (sub-)reach (in the paper from 1 km to 8 km long) which is a fraction of the original concept of "reach" in the Linsley et al. (1982) sense. Notwithstanding this comment, what has been done in the paper is to demonstrate the relative insensitivity of the solution with respect to the number of sub-intervals, in cases where their length is of the order of a kilometre or so. The author states (p 1551, 2nd paragraph) "In 1969, Cunge - - - [proposed] a particular estimation of its parameter values which would guarantee that the real diffusion would be equalled by the numerical diffusion." This statement supports the results in table 2 where the peak flow is nearly constant (surprisingly it rises) as Dx is varied, nevertheless, the choice of Dx seems to be arbitrary. In the light of these comments, would the author dare to propose a "rule of thumb" for the choice of Dx in applications?

Minor points: p 1557 line 1: "Numerical example" section 7. pp 1578 & 9: the tables are almost illegible they are so small. The description of the contents of the tables

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does not appear in the text nor in the table captions, which should be remedied - the inference drawn from them is not directly self-evident.

Finally, the name Cappelaere has been mis-spelled throughout.

ref Linsley RK, Kohler MA and Paulhus JLH, (1988). Hydrology for Engineers, 3rd edition, McGraw Hill.

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