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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Conservative finite-volume forms of the Saint-Venant equations for hydrology and urban drainage" *by* Ben R. Hodges

Anonymous Referee #1

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The paper presents new conservative forms of Saint Venant Equations. It reviews classical forms of SV equations and introduces new ways to present it. According to the manuscript, these new SV eq may be more appropriated for applications in hydrology and urban drainage. Saint Venant equations are one of the most important in water resources field but it is still not always easy to solve it in hydrodynamic models due to the nature of the problem. Improving methods for hydrodynamic modelling is an important challenge, given new input that data types and availability, and applications. So the goal of the manuscript is relevant. It is generally well written and the ideas proposed seem correct. However, I fell that the paper would benefit from a few improvements to make it an stronger contribution: (i) better intro based on previous work (ii) better

explanations on the equations, with more figures showing concepts (iii) a few examples showing the value of the proposed new forms of SV equations. Detailed comments are provided below. I hope it can help the author to improve the manuscript.

Introduction:

The intro section focuses on detailed explanations of different forms of SV equations that helps to identify how to write SV model in a more conservative form. The manuscript argues that this new form is proposed to address challenges in modelling large scale river networks and urban drainage system. However, there is no clear demonstration of past research showing that the major modelling challenges are associated with the form of SV equations. For example, there are several recent research using the local inertia approximation of SV solved with an explicit scheme proposed by Bates et al. (2010), that is now used in several models (Camaflood ,Yamazaki et al,. 2013; Lisflood-FP ,Neal et al., 2012; MGB, Pontes et al., 2017, Siqueira et al., 2018) to simulate large basins and continental to global scale. But this past research did not documented problems related to forms of SV equation. What are the current difficulties? What could be the benefits of a new one ? Improved model stability? Accuracy? For example the scheme from Bates 2010 neglects advective inertia. . . . computational efficiency ? These issues should be discussed in the introduction , based on previous research, to convince a broader audience that this new form of SV equations could be useful to improve their simulations. Also, most of the detailed explanations presented in the introduciton should be moved to section 2.

Page 3 Line 20 – 25. Equation 8. Explain why f1 and f2 are necessary in eq 8 while it was not necessary in eq. 7.

Section 2. Page 4 line 7. Review the frictional force per unit area.

Page 4 lines 17 – 29. Also review recent work using local inertia aproximation from Bates et al. 2010 for large scale river networks.

Page 4 lines 17 – 29. Review work for short scale using HEC-RAS.

Page 5 Lines 5-15. Please discuss explicit vs implicit sechemes. Discuss local inertia explicit formulation. Review 6 point Abbot and Ionescu scheme (1967). Explain that Preissman scheme is a finite difference based on integral relations that improve conservation.

Section 3:

Please use more figures to help the reader to understand the paper.

Equation 13. Please use a figure to define the control volume Page 8 line 2. "This vector is local and change along the channel . . ..". Please use a figure to clarify it.

Page 8 line 25. "It is known that . . ..". Please cite references showing these arguments. Page 9 Line 13. Figure defining the free surface slope n(x), these angles, etc. Eq 25. Why P(x) is independent to z? How the shape of cross section and its variability is considered?

Page 12 equations 27, 28, 29. What is m? What lambda represents? Is it just a mathematical trick ? Or does it have any physical meaning? How it relates to zb(x) ? How it relates to river cross section shape and its variation along x? Why int (lambda) = 1 ? (eq 28)

Equation 32. Ve is confusing here. It is volume but one can make a confusion with flow velocity. Please, use a good figure to define the control volume, what is Ve, Le, upstream and downstream cross section, etc.etc. . .

Equation 33. How gAn was obtained? Define how gAn is derived from P, using water surface n instead of depth H.

Section 4. Please define the meaning of lambda function. It is important to understand the choice for polynomial approximations.

Please show in a figure the approximations T(0,0), T(1,0), T(2,0), T(1,1) of n(x) and

lambda(x) or zb(x).

Equation 60. Check it. I guess the last term is g.Ae.Le.Sfe.

Pg 19, line 22. "S0 brings a host of problems". What problems? Please show it based on past publications.

Eq. 62. Not clear.

Final discussions and conclusions. In my view, the paper would be much more convincing if a few examples showing that application of the new forms of SV equations provide the same results as other classical forms or better results in critical cases.

Pg 2 Line 26: breadth = width ??

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