Hydrol. Earth Syst. Sci. Discuss., 8, C1450–C1453, 2011
www.hydrol-earth-syst-sci-discuss.net/8/C1450/2011/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Discharge estimation in a backwater affected meandering river" *by* H. Hidayat et al.

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Received and published: 16 May 2011

We would like to thank Prof. Koussis for his assessment of our paper and for his valuable comments. Replies to the comments are given below.

Comment: From the authors' presentation, the characterisation of their method (DSM) as stochastic does not appear plausible; perhaps, a little additional information would clarify this point.

Reply: The method is called semi-stochastic as we apply a regression model to estimate total discharge from specific discharge, using an amplification factor that depends only on the position in the cross-section. In the revised ms we mention this explicitly.

Comment: A more detailed sketch than that given in the lower Fig. 2 should be provided to explain symbols used in the text and equations in sections 2 and 3: d, z, H, η.

Reply: we have improved Fig. 2 by better showing the reference level.

Comment: The additional and traditional component of the paper, concerning flood dynamics treated via 1-D hydraulic equations, is also useful, but should be improved. The improvement concerns mainly the correction of an error in the Jones formula related to the celerity c. The authors write (p. 2678, lines 6-8) "The celerity c was estimated from $c = \sqrt{gd}$ (Ligget and Langley, 1998), where g is gravitational acceleration and d is hydraulic mean depth, according to $d = A/b$." The authors use incorrectly the celerity of dynamic waves in the Jones formula; they should use the celerity of kinematic waves, $c = dQ/dA|x = const.$, which is typically evaluated from steady-state flow rating curves [closer to the physics, but more involved computationally, is an iterative evaluation based on the looped rating curve, as suggested by Koussis (2010)].

Reply: In the revised manuscript we have computed the celerity of kinematic wave according to $c = dQ/dA|_{x=const}$ from the steady flow rating curve obtained for Melak, $Q = 125.98 * (h_0 + 1.5)^{1.256}$. The value of the kinematic wave celerity is indeed less than that of the dynamic wave. Celerity, however, is not a very sensitive parameter in the Jones'formula and as the reviewer expected, this correction affected the estimated discharge only slightly.

Comment: The authors should also provide the value of the bed slope.

Reply: The bed slope value has been included: The bed slope of $^{-4}$ was estimated from the Mahakam River bed level profile derived from SRTM data by van Gerven and Hoitink (2009).

Comment: The authors write (p. 2680, line 29) that there is no theoretical justification for using the kinematic wave equation in the Jones formula to replace the surface gradient term $\partial h/\partial x by (1/c)\partial h/\partial t$. It would be better to say that the replacement of the surface gradient term by the time derivative of the depth divided by the kinematic wave celerity is an approximation, the accuracy of which depends on the closeness of the actual flood wave to the kinematic wave.

Reply: We replaced the sentence about the theoretical justification of the kinematic wave assumption by 'Although this approach can be succesfull under certain bed slope and flow conditions (Pearson, 1989, Perumal et al., 2004, Dottori et al., 2009), the kinematic wave equation cannot capture discharge dynamics in backwater affected river reachs (e.g. Tsai, 2005).'

Comment: In the particular case studied, I concur with the authors that the Froude number value F = 0.01 indicates likely negligible inertial terms, although it must be said that Henderson's assessment of the magnitude of the inertial terms relative to the free-surface slope as $O(F^2)$ rests on the assumption of a quasi-kinematic flood wave behaviour.

Reply: We added a reference to the work by Pearson (1989), who presents a non-dimensional version of the St. Venant equations from which it becomes clear that the inertial terms drop out for small values of the Froude number. There is no assumption about flood wave behaviour being quasi-kinematic necessary for this.

Minor comments

Comment: It is not entirely correct to refer to Eq. 10 as the Jones formula. Jones proposed the zero inertia approximation, but it was Thomas who replaced the spatial derivative term by a temporal derivative term, in order to enable estimating the discharge from at-a-station stage measurements [see Henderson (1966)]. Better term: Jones-Thomas formula.

Reply: After introducing Jones'formula we added: 'Strictly speaking, it may be more correct to refer to Eq. 10 as the Jones-Thomas formula, as it was Thomas who replaced the spatial derivative term by a temporal derivative term, in order to enable estimating

the discharge from at-a-station stage measurements (A.D. Koussis, pers. comm.).'

Comment: The authors' statement about lateral water level gradients having been ignored in previous work overlooks the fact that 1-D hydraulics inherently cannot take lateral water level gradients into account. Out-of-bank spills and return flows from flood plains should be also included among the possible reasons for the failure of the Jones-Thomas formula to adequately predict flood dynamics; such phenomena more than test the limits of 1-D hydraulics.

Reply: We agree to mention out-of-bank spills and return flows from flood plains as other possible reasons for the failure of the Jones formula to adequately predict flood dynamics. Indeed, such phenomena were observed during flood peak period in the study area. We changes the ms accordingly.

Comment: What is the purpose of the statement in the Introduction (p. 2670, lines 8-11) "Backwater from one or several downstream elements..., causing curved longitudinal surface level profiles for a constant and uniform river discharge."? If it means that, depending on the boundary condition, different (curved) water surface profiles result for a given flow rate, this is correct but well known. What am I missing here? Rephrasing might help.

Reply: The purpose of the sentence is to introduce the reader to causes of backwater effects on stage-discharge relations at a gauging station. Omitting the part that the reviewer views as well-known, the sentence has been rephrased into: Backwater from one or several downstream elements such as tributaries, lakes, ponds or dams, complicates rating curve development at hydrometric gauging stations (Petersen-Overleir and Reitan, 2009).

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 2667, 2011.