Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-531-RC2, 2016

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Cascade of submerged reservoirs as a rainfall-runoff model" *by* Jacek Kurnatowski

Anonymous Referee #2

Received and published: 6 December 2016

General The paper presents the mathematical derivation of an analytical solution of a cascade of submerged reservoirs. The solution is provided in terms of Chebyshev polynomials, which have the property to be orthogonal and for which polynomial roots can be found. The author applies the solution to a unitary volume to generate a unitary hydrological response hydrograph (IUH) for a number n of reservoirs, allowing to analyse the sensitivity of the solution to increasing n. The author continues with an inter-comparison of his approach with the classical n-reservoir Nash cascade in terms of IUH and recession curves. The principal behavioural difference with respect to the submerged reservoir cascade is given by the smoother recession curves in the submerged reservoir model, suited for baseflow response representation. Finally, an application of both approaches for modelling the recession curve of a real catchment is presented. The proposed method shows higher Nash-Sutcliffe efficiency values than

the Nash cascade for the study particular situation. The authors analyse only the zero forcing case (P=0) with one or multiple reservoirs that are emptying.

Comments The application is mathematically sound but the advantage and limitations for practical applications of the methods has not been sufficiently emphasized. One of the principal appeals consists in the computational efficiency due to the analytical tractability of the problem. The applicability to a raster-based spatially distributed catchment representation could be discussed, including the computational advantages of using analytically tractable linear reservoir equations on large distributes rasterized computations. The absence of a rapid surface runoff component, which is responsible for fast increasing hydrographs, cannot be addressed by the proposed reservoir approach in its current form, which makes it limited in scope for more general applications where base flow effects are secondary. The fundamentally linear structure of the modelled hydrologic response signal prevents use in situations with typically non-linear (e.g. hysteretic) response patterns. This issue has not been discussed in sufficient depth. Given that the focus of the manuscript is mathematical, the author could try to provide an expression of the time to peak in terms of k and n for reservoirs that have equal k constants and perform a sensitivity analysis in terms of k also. In the conclusions it is not clear what the author means by "non-integer" number of reservoirs. I am of the opinion that the number of reservoirs should always be integer.

Language: It is recommended to check the language of the paper For instance Lines 5-10 need rewording, for instance the sentence " Therefore the above concept of submerged cascade requires the modification facilitating calculations of the consecutive eigenvalues. The sentence "this can be done .... for the last reservoir in a chain twice" does not correctly describe what is done in Eq. 9. The word "researches" has been used more than once in an unsuitable context (e.g. see conclusions).

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-531, 2016.