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Interactive Comment

Interactive comment on "Contribution of directly connected and isolated impervious areas to urban drainage network hydrographs" *by* Y. Seo et al.

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Referee #1

General comments: This study calculates drainage runoff hydrographs zonsidering the effects of infiltrated rainfall and directly connected and isolated impervious area. The observed recession of the hydrographs in urban areas indicates the modeling deficit of most hydraulic models like SWMM. The suggested approach of conceptual hydrologic modeling effectively improves the simulation of the recession and water balance in urban areas. In spite of the limited number of observation, the paper suggests the need to consider the amount of water in urban areas, which has not been considered in the typical hydraulic and hydrologic modeling in urban areas. Moreover, considering the connectivity of impervious areas in urban catchment and evaluating the effect of directly connective impervious area (or effective impervious area) is important but not has been reflected in the modeling approaches. Therefore, the modeling approach suggested in this paper can be a start to incorporate this in urban hydrologic modeling. However, since parameter (2 parameters in the suggested approach) calibration is still required in the suggested model, I wonder if some simple conceptual approach might be possible without model calibration processes. Of course, I agree with the authors in that the actual process underneath the urban surface cannot be explicitly explained because of the complexity and hydrologic models are necessary and clearly graining grounds at this point.

Answer: The authors thank the reviewer for the comments.

Basically, the authors agree with the reviewer in that a conceptual approach can be introduced instead of the 2-parameter model in this study. This study showed that the 2-parameter model, which has the form of the solution of an advection-diffusion equation, is one of the possible approaches regarding the contribution of the infiltrated amount of rainfall to the runoff. However, please note that, as the referee #2 pointed out, SWMM has a subsurface flow routing subroutine called GROUND in Runoff Block based on physical processes of groundwater with a number of parameters. In contrast, this study suggest a relatively simple approach, which enables us to assess the fate of the infiltrated water that eventually reaches to the main drainage network and contribute to the direct runoff hydrograph by a parameter rb.

Minor comments: Line 7, page 6 Is the assumption of a wide rectangular channel geometry, which is mostly appropriate for natural channels, still appropriate for urban drainage systems? Since most urban drainage systems have geometry, which is not that wide, it might be cautious to apply the same assumption.

Answer: Please refer to lines 15-16, page 6. We assumed a circular cross section for the main drainage geometry and the celerity and the diffusion coefficient of flood waves were determined from circular cross section geometry.

Line 15, page 6 Assuming the drainage network consists of pipes with circular cross-sections might conflict with the Van de Nes's original assumption.

Answer: Van de Nes derived the celerity and diffusion coefficient of flood propagation assuming a trapezoidal cross section. In this study, the celerity and the diffusion coefficient of flood waves were derived from a circular cross section. The derivation detail is not presented in the manuscript, but it can be found in Appendix A of Seo (2012).

Line 21, page 7 Assuming the drainage network flow as an open channel flow can be an issue, because of the pressurization of the drainage system. The authors need to clearly mention the limitation of the suggested approach in the discussion or conclusion section.

Answer: We fully understand the reviewer's concerns about the pressurization in pipes. We, therefore, mentioned that the suggested approach is hydrologic rather than hydraulic and also clearly mentioned the limitation of the suggested approach in the conclusion section. There are some schemes to deal with this (such as Preissmann Slot) but we left these improvements to the future study.

Line 23, page 12 It is nice to incorporate the effect of DCIA, which is often referred to as effective impervious area in other literatures. The connectivity of impervious areas in urban areas is receiving more and more attention in terms of hydrologic modeling. I noticed some literatures about the effective impervious area, especially the methodology to estimate this. The authors need to study further on this topic and discuss more about this. For example, the authors should refer to following articles: Roy and Shuster, Assessing impervious surface connectivity and applications for watershed management, Journal of the American Water Resources Association, 45(1), 2009 Han and Burian, Determining effective impervious area for urban hydrologic modeling, Journal of hydrologic engineering, 14(9), 2009

Answer: The authors thank the reviewer for introducing literatures on the study of DCIA, especially, in terms of accurate estimation of DCIA in urban catchments and its implication. We will include a short summary about the referred articles in the manuscript.

Line 2, page 10 Assumption of a two-parameter inverse Gaussian needs further discussion. I understand that the proper formulation of the delayed response can be difficult. However, the author should provide more background on this or clearly mention the limitation of this assumption in the discussion and conclusion section.

Answer: The authors thank the reviewer for mentioning this. Meija and Moglen (2010) that they assumed a two parameter inverse Gaussian travel time distribution for both hillslope and channels to derive a geomorphologic unit hydrograph for a natural watershed. The basic idea is that we extend the response function of the main drainage network, which can be approximated by the solution of the advection-diffusion equation of flow perturbation, to that of delayed response of infiltrated water. The advection-diffusion equation basically describes physical phenomena where particles, energy, or other physical quantities are transferred inside a physical system due to two process: diffusion and advection. To think of the delayed response of infiltrated amount of rainfall water, the solution of advection-diffusion equation (an inverse Gaussian form of solution) can be a good approximation. As the reviewer mentioned, the limitation of this conceptual approach will be mentioned in the discussion and conclusion section.

References Seo, Y: The effect of rainstorm movement on drainage network runoff hydrographs, University of Illinois at Urbana-Champaign, Urbana, IL, 2012.

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