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Hydrology and Earth System Sciences
Discussions



# *Interactive comment on* "A geohydrologic framework for characterizing summer streamflow sensitivity to climate warming in the Pacific Northwest, USA" *by* M. Safeeq et al.

**Anonymous Referee #3**

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This article provides an interesting and simple framework that seeks to evaluate the role of sub-surface watershed drainage efficiency in mediating summer streamflow response to climate warming. The paper leans heavily on a conceptual model presented in earlier work by Tague and Grant (2009); the authors extend this framework by generating a regression model that is used to map (1) the recession coefficient (k) and (2) sensitivity of summer streamflow to changes in the magnitude and timing of recharge. The paper is scientifically sound, tackles a challenging and important water management issue and is recommended for publication once the following concerns are addressed: (1) P3320, Section 3, A complete formulation of equation (1) takes the



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following form: dS/dt = IR + IM + GWIN – ET – Q – GWOUT where GW is groundwater. The authors neglected to include groundwater terms in their water balance approach. Given the susceptibility of mountain catchments to inter-catchment groundwater exchange I find it dubious to omit a GW term, especially considering work from Jefferson et al. (2006) demonstrating the inability of topographically defined watersheds to describe aquifer boundaries within the Oregon Cascades. It would be helpful for the authors to discuss the potential influences of inter-catchment groundwater exchange on estimates of streamflow sensitivity and how this complicates mapping streamflow sensitivity to the natural landscape. (2) P3326, Section 4.1.2, Reporting adjusted R squared metrics ranging from 0.43 to 0.58 as reasonably accurate may be misleading, I would prefer the authors simply offer the values and allow the reader to judge their accuracy. Also the statement that "Irrespective of geographic domain (OR, WA or both combined), it is apparent that the regression models provide estimates of k with reasonable accuracy" seems speculative. If possible, the authors conjecture should be supported by citations of existing work where metrics/estimates of drainage efficiency (such as k) may have been evaluated using other techniques. (3) P3330 Section 6.1 Comparing St to $\varepsilon$T is difficult, I encourage the authors to think of other possible metrics for comparing empirical results to analytically derived ones such as (ST). (4) These groundwater-dominated landscapes in effect "remember" changes in climate as reflected in either the magnitude or timing of recharge in the winter or spring, resulting in higher sensitivity of late-season streamflow. The authors refer to groundwater dominated catchments and their "memory" to climate; this has been noted by Godsey et al. (2013) where summer low flows within certain Sierra Nevada, CA catchments exhibited significant correlation to the previous year's snowpack (i.e. summer low flows do not only depend on the current Q0). Because of how Q0 is defined (equation 2), it neglects to incorporate any "memory" effect from previous recharge events. Given the potential for catchments within the authors' study area to exhibit these "memory" effects it would be beneficial for the authors to acknowledge the limitation of Q0's current definition and to discuss how their framework could incorporate additional metrics to evaluate



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potential “memory” effects. (5) P3337 Section 8, the authors refer to a “geoclimatic framework” whereas the title and elsewhere in the article use the term “geohydrologic framework”, choose one term and be consistent throughout. Typos P3326 L4, “. . . variables are used predict k,. . .” please insert “to” between “used” and “predict”. P333a L7, Please remove the word “in”. References Godsey, S. E., Kirchner, J. W. and Tague, C. L. (2013), Effects of changes in winter snowpacks on summer low flows: case studies in the Sierra Nevada, California, USA. Hydrol. Process.. doi: 10.1002/hyp.9943 Jefferson, A., G. Grant, and T. Rose (2006), Influence of volcanic history on groundwater patterns on the west slope of the Oregon High Cascades, Water Resour. Res., 42, W12411, doi:10.1029/2005WR004812. Tague, C., and G. E. Grant (2009), Groundwater dynamics mediate low-flow response to global warming in snow-dominated alpine regions, Water Resour. Res., 45, W07421, doi:10.1029/2008WR007179.

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