Hydrol. Earth Syst. Sci. Discuss., 8, C5218–C5221, 2011
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Hydrology and Earth System Sciences Discussions

Interactive comment on "A simple water-energy balance framework to predict the sensitivity of streamflow to climate change" *by* M. Renner et al.

M. Renner et al.

maik.renner@mailbox.tu-dresden.de

Received and published: 12 December 2011

We are grateful for the positive review of Dr. Teuling (Referee II) of our manuscript.

The definition of catchment efficiency in the context of the concept of Tomer and Schilling (2009)

The major concern of Referee II is the definition of the term catchment efficiency (CE) and its use to provide a theoretical basis for the concept of Tomer and Schilling (2009). He argues, that the manuscript does not provide a theoretical foundation for the con-

cept of Tomer and Schilling (2009).

Our aim was not to define a new "fundamental catchment property" (Referee II), but to have a measure which considers, both the water and energy balance equations, with respect to (a) actual evapotranspiration and (b) its main drivers, water and energy supply. The simple sum of both the ratio of E_T/P and E_T/E_p provides such a measure. It may be interpreted from an ecohydrological point of view: We regard a catchment as an ecosystem and assume that maximizing evapotranspiration E_T (treating transpiration as equivalent to biomass production, an often used concept supported by e.g., Steduto and Albrizio (2005) and references therein) is the driving objective of this ecosystem. This aim can be achieved by maximizing both, the use of available water $\frac{E_T}{P}$ and the use of the available energy $\frac{E_T}{E_p}$ for evapotranspiration. Whereby both ratios can be derived directly from the long term water or energy balance equations, respectively. Thus, the sum of both ratios which we term catchment efficiency, can be regarded as the objective function which needs to be maximized.

We also find CE useful in interpretation and it may serve as a catchment parameter for a Budyko type of function (eq. 28).

Clearly, there may be other, and better ways of defining such a measure, maybe using the product of both ratios as referee II suggests, but this is beyond the scope of this manuscript. To come back to the concern of Referee II we will add the main discussion points above to section 2.2. We also understand, that this is rather an explanation than a mathematical foundation for the concept of Tomer and Schilling (2009). Thus, we will change phrasing in the respective sections in the revised manuscript.

Other remarks of Referee II

Number of Budyko curves

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This question is dealt with in the reply to the first referee.

Page 8794, Line 9: Theoretical foundation or explanation?
Given the discussion above, we change "foundation" to "explanation".

Page 8798, Line 6: whether or either?

Thank you, "either" is correct.

Page 8803, Line 11: numerical or analytical?
"analytical" is correct. Will be changed in the manuscript.

Page 8808, Line 21: "to sustain ET " -> not clear. Do you mean to sustain ET at the potential rate? Or, to sustain any evaporation. In this case please rephrase into: "which implies no precipitation, no streamflow, as well as not enough water to sustain any evaporation."

Thank you, we will use this correction.

Best Regards,

Maik Renner (in the name of my coauthors)

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References

Steduto, P. and Albrizio, R.: Resource use efficiency of field-grown sunflower, sorghum, wheat and chickpea:: II. Water use efficiency and comparison with radiation use efficiency, Agricultural and forest meteorology, 130, 269–281, 2005.

Tomer, M. and Schilling, K.: A simple approach to distinguish land-use and climate-change effects on watershed hydrology, Journal of Hydrology, 376, 24–33, doi:10.1016/j.jhydrol.2009.07.029, 2009.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 8793, 2011.