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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Why has catchment evaporation increased in the past 40 years? A data-based study in Austria" *by* Doris Duethmann and Günter Blöschl

Anonymous Referee #2

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To fully appreciate this paper, one needs to first consider adopting the traditional approach to studying climate change impacts on long-term water balances. Say one builds a model of long-term water balance – with fixed parameterizations of runoff and evapotranspiration as functions of soil moisture. Then calibrate the model with past runoff and then impose some kind of future climate and make a prediction of what the water balance will be like in the future under the changed climate. The main message coming out of this paper is the fallacy of this kind of approach. I believe that this paper is an important milestone in the study of climate change impacts on catchment water balances.

The paper focuses on long-terms changes in evapotranspiration across Austria based on water balance analyses using observed data on P and Q: and estimation of E as the residual P-Q (assuming negligible ïĄĎS, which they justify based on measured groundwater levels across Austria). The main outcome of the water balance study is that there has been a significant increasing trend in ET (water balance based estimate) over the past 40 years, even as there is no significant trend in Q over the same period. This is intriguing, although the authors say this has been observed in other places too. Why would ET increase and yet Q would remain the same?

The authors carry out a detailed attribution study to discover the possible causes of this phenomenon. The analyses lead them to conclude that the increase in ET is attributable to 3 apparent causes, in almost equal measure: atmospheric conditions (radiation, temperature), vegetation activity (i.e., NDVI) and precipitation. No problems so far for me. Under atmospheric conditions VPD was looked at and did not have much of an impact: a reviewer questioned why wind speed was not looked at – hopefully the authors would clarify that.

The authors explain the dependence of the ET change (partly) on change of precipitation is as a result of increased soil moisture arising from the precipitation change. Here is where I have some concern - I have trouble grasping the attribution to soil moisture change. Why would there be increased soil moisture when P and ET are changing in the same direction? I have trouble understanding it. Furthermore, if there is increased soil moisture why is Q not increasing? I would not be so quick to jump to this conclusion: perhaps they can take it more slowly, and in steps.

Precipitation and atmospheric demand are both increasing, but at the same time for these same reasons (and other reasons, e.g., temperature) I can understand vegetation activity being increased, which probably removes the increased soil moisture in the root zone due to the increased precipitation (leading to increased ET) but without increased recharge, which keeps Q the same. Not sure if this logic is right.

In any case I am afraid the observed phenomenon may not be fully explained without invoking changes to seasonal variability (of everything, especially NDVI). There must be some kind of nonlinearity caused by changes to the seasonality, which may contribute to the phenomenon. In other words, changes in precipitation and radiation (and wind) propagate through the system in more complex ways than the authors have concluded in the paper. For the present, the paper requires some moderate revisions to address these issues.

I suggest that the authors try to refine their attribution exercise to account for this complex system perspective, and to allow for seasonality changes to play a role in contributing to the phenomenon. A further suggestion, anticipating future studies, is to present a conceptual model (in the form of a causal loop) that possibly accounts for some kinds of feedbacks that may need to be invoked to fully explain the phenomenon. The current paper looks like a stepping stone towards a more comprehensive model of the system in the future.

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