Hydrol. Earth Syst. Sci. Discuss., 12, C1–C6, 2015
www.hydrol-earth-syst-sci-discuss.net/12/C1/2015/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Stream flow recession patterns can help unravel the role of climate and humans in landscape co-evolution" *by* P. W. Bogaart et al.

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Received and published: 23 October 2015

Summary
Destouni et al. (2013) showed that hydropower dams and agriculture increased evapotranspiration and reduced river discharge in 9 major catchments in Sweden since 1900. Van der Velde (2013a) build on these results and found evidence for strong increases in evapotranspiration flux of agricultural and forest areas in southern Sweden. Based on these studies this paper aims to determine regional patterns in river recession behavior of 200 Swedish catchments to unravel the natural and anthropogenic controls creating these patterns and changes thereof. They use the Brutsaert and Nieber (1977) anal-

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ysis method to characterize streamflow recession behavior. The resulting parameter values of a and b, which are obtained through fitting, are used to find spatial patterns and trends in river recession. The hypotheses of this paper states that human modifications to the natural system alter storage-discharge and associated recession dynamics of catchments directly or through co-evolution of soil, vegetation, climate, and landscape which in turn change the annual evapotranspiration and discharge fluxes. Eventually the paper concludes that many of the found trends and patterns in recession parameters could be attributed to various natural and anthropogenic drivers.

Coastal regions are sensitive to river discharge and/or river water quality stresses. One of the coastal regions which experience those stresses is the Baltic Sea (Darracq et al., 2005; Dargahi and Cvetkovic, 2011). Relating river discharges to landscape characteristics via a regionalization approach is crucial for understanding the cause of these stresses (Van der Velde, 2013a). This paper uses this regionalization approach to take a step towards understanding the causes of these stresses.

The paper is mostly well written and the tables and figures are often clear. However, I have some remarks. The first major remark is about the used fitting and extraction methods for the data analyse; the assumption that on all 200 catchment the same methods can be applied is not well-founded. A second major remark is about the way the power law is fitted through the recession data. The last major issue has to do with the effect of evaporation on the recession analyse; which seems to be neglected. In addition, I have some detailed and specific comments. I therefore recommend a minor revision before publishing.

General comments

1. The paper concludes that the least variability in estimation of b, y (same conceptual meaning of a) and T (1/a) is obtained from the VOG extraction method and the REG fitting method (Appendix A) based on a study of Stoelzle et al. (2013). Indeed this combination of extraction and fitting method did have the least variability. But Stoelze et al. (2013) also suggest paying attention to the extraction of different stages

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of recession, and also to the physical meaning of different fitting methods (e.g. lower envelopes representing slowly receding streamflow recessions), as they focus on a specific storage–outflow relationship. Stoelze et al. (2013) also concludes that inconsistency found among the methods presents a limitation for regionalization, because it has shown a wide range of recession characteristics calculated for one specific catchment with particular physical characteristics. This said, a more in-depth study of most suitable methods for this study is therefore required. For example use the climate, land cover, elevation and soil characteristics for each of the analyzed catchment adopted from van der Velde et al. (2013a) to determine the most suitable fitting and extraction method for each catchment. This can be done by grouping the catchments with the same characteristics and use different methods per group to determine which methods fit best by a group of catchments with the same characteristics.

2. In the paper the authors fit a line to the whole cloud of recession data to determine the Brutsaert-Nieber parameters. However, by viewing to individual recession events in a cloud of recession data, Shaw et al. (2012) strongly suggest that the most appropriate way to interpret dQ/dt-Q data points is not to fit a line along an envelope of the data cloud or through the center of the data but to select specific points that are representative of the process of interest. In the paper of this research they are interested in the effects of co-evolutionary processes on the hydrological cycle (e.g. geomorphological cycles). When selecting specific points that are representative for each of the processes the way to unravel the role of climate and humans in landscape co-evolution is easier and more precise.

3. Several studies have shown that evapotranspiration has a considerable effect on streamflow recession, e.g. Tschinkel (1963), Weisman (1977), Federer (1973). In this paper a seasonal variation is recognized in the recession behavior which follows the seasonal change. In the discussed paper the effects of evapotranspiration seems to be neglected in the extraction of suitable data points. A solution to this comment, according to Teuling et al. (2009), is to select periods when evaporation (and snowmelt) can be neglected. For the method in which the periods should be selected I would like

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to refer to Teuling et al. (2009).

Detailed comments

1. P9872, 6-7: “Seasonal deviations from the wintertime recession curve have been used to measure catchment scale evaporation.” In this study? Not really clear sentence.

2. P. 9866, 8-10 : “Results suggest that the Brutsaert-Nieber parameters are strongly linked to the climate, soil, landuse, and their interdependencies.” Is this a result of this paper? Because this is something that is already known. (Lyon et al., 2009, Brutsaert, 2008, SjoÌĹberg et al., 2012)

3. P. 9893 19-22. : In the last phrase of the conclusion the authors suggest one possible implication of the found results: “One possible implication of these results is that models targeted at long-term prediction of stream flow dynamics should take into account the dynamical nature of catchment properties, especially the feedbacks associated with co-evolution of soils, vegetation and land use.” However, the feedbacks mentioned in this phrase cannot be found in the article. The only mentioned feedback in the paper is the one whereby an increased precipitation rate may lead in an increased drainage density. But a lack in data on drainage density leaves this potential geomorphological feedback unresolved.

4. P. 9866 12-15: “Many catchments show a trend towards more non- linear behavior, meaning faster initial recession, but also slower recession towards base flow. This trend has been found to be independent from climate change. Instead, we suggest that land cover change, both natural (restoration of natural soil profiles in forested areas) and anthropogenic (reforestation and optimized water management), is probably responsible.” I think the last sentence represented this paper really well. Which brings us back to title of this paper “Stream flow recession patterns can help unravel the role of climate and humans in landscape co-evolution” The title and the sentence in the abstracts is contradicting because it is not known if stream flow recession patterns can help.

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Specific comments

1. P. 9868, 24: the word “catchment” is used consecutive
2. P. 9884, 3: the word “lead” is used consecutive
3. P. 9866, 3-5 : “However, due to co-evolution of many of landscape properties more sophisticated methods to quantify future landscape-hydrological model relationships are likely necessary.” Is a vague sentence, better use: “However, due to co-evolution of many landscape properties more sophisticated methods are necessary to quantify future landscape-hydrological model relationships.”

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 9865, 2015.