Hydrol. Earth Syst. Sci. Discuss., 12, C2903–C2909, 2015
www.hydrol-earth-syst-sci-discuss.net/12/C2903/2015/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Importance of maximum snow accumulation for summer low flows in humid catchments" *by* M. Jenicek et al.

Anonymous Referee #1

Received and published: 29 July 2015

Jenicek and colleagues present a data driven study, which uses climate and runoff data to study the effect of snow storage and precipitation on summer low flows for 14 catchments in Switzerland. The main findings of the paper are (i) maximum winter snow accumulation influenced summer low flow, but is not the only controlling factor, (ii) in years with below average precipitation amounts during spring and summer the importance of snow accumulation increased, (iii) the sensitivity of summer low flow to snow accumulation is higher in high elevation catchments. Although understanding the role of (changing) snow conditions on summer low flows is a relevant topic for HESS I do have some serious concerns about the current version of the paper, and the papers needs to be significantly improved before this paper can be considered for publication in HESS:

1. I am not sure if the findings of the paper are significantly novel, or if they provide useful new insight in the role of snow for summer low flow conditions, because the analysis only relies on statistical relationships between snow conditions and summer low flow conditions but does not provide any mechanistic explanations of the relationships you describe. The statistical findings by itself (in my opinion) only confirm some obvious qualitative findings that are not surprising: the fact that *(i) maximum winter snow accumulation influenced summer low flow, but is not the only controlling factor* is not surprising, and differences with for example Godsey et al. [2014] are not really surprising either if you consider the strong Winter dominated precipitation regime of the Western US compared to more constant (and even sometimes summer dominated) precipitation regimes of Switzerland. Also finding (ii) *in years with below average precipitation amounts during spring and summer the importance of snow accumulation increased* only seems obvious to me, similar to (iii) *the sensitivity of summer low flow to snow accumulation is higher in high elevation catchments* because in these catchments snow is a higher fraction of the total water balance of the catchment (compared to rain) thus a % change in snow is likely to lead to a larger % in runoff (if all other factors are the same). I do not argue that results of empirical analyses are only valuable if they confirm some unexpected, but I do think there is some novelty lacking in this paper as I don't see how the paper really provides new understanding, refined previous understanding, or helps with better prediction of summer low flow conditions in Switzerland. Thus, I would recommend the author's to (i) either write the manuscript such that novel contributions are better highlighted where you show how we really improved our understanding of ability to predict, or come up with some additional analyses that would allow this.

2. You choose at set of 8 predictors for summer low flow conditions. Maybe the choice of indicators is obvious for you, but clarify why you chose them.

3. You state that *"maximum winter snow accumulation influenced summer low flow,*

but could only partly explain the observed inter-annual variations. One other important factor was the precipitation between maximum snow accumulation and summer low flow". Although I agree with statement, I think the manuscript lacks a more thorough discussion of other factors that can explain low flow conditions. As an example, what about evaporation differences between years? They are a major component of you catchment's water budget, affect water storage (and thus low flow conditions), but are completely unmentioned. Or what about the role of landscape draining properties (e.g. Tague et a., [2004])

4. The analysis is based on catchment average values and the catchment divided into two parts. Is this strongly limiting your analyses for a catchment larger than 1500km2?

5. I have difficulty to efficiently read the results section. The section refers to the graphs and tables but does not explicitly takes the reader by the hand in explaining what part of the graph we should focus on when you conclude anything from these graphs.

Technical comments

- Abstract Line 3: It isn't really "winter" precipitation that is sensitive to temperature changes, which implies a 3-month season, but rather something like "cold season".
- Lines 3-4: "snow" does incorporate both "snowfall" and "snow storage"?
- Line 4-5: Does it necessarily relates to "groundwater" recharge as water in some catchments may mostly only reach the unsaturated zone?
- Line 8: Instead of "snow", be specific if you mean "snowfall", "snowpack" or both.

- Line 21: since you haven't defined the elasticity index it is difficult to interpret your statement by just reading the abstract.
- Introduction (7025), Line 2-3: Is "The shift from snowfall to rain" one of the most important effects of predicted climate change "in general" (as you currently state) or "on the hydrological cycle".
- Line 9: The reference of Berghuijs et al [2014] studies inter-annual and mean-annual water balances and only speculate what the changes in seasonal hydrology could be. Hence the reference is not really appropriate here. Also, please be specific with what you mean by "might influence"; e.g. modelling results indicated that . . ..
- Line 10-21: There are clear differences between the findings of the reduced snow days in Switzerland (mainly in spring) and western US (mainly in Winter). It might be good to highlight that more explicitly.
- Introduction (7026), Lines 8 - 12: Since studies find regional differences in the streamflow trends, do they also have different physical explanations, and are these explanations relevant to mention?
- Line 15: "above 1000ma.s.l. and below 2500" or "between 1500 and 2500 m.a.s.l"?
- Line 16: Can you be more specific than "more sensitive"? Was it a large or small difference? Does this still focus on mean runoff?
- Line 26-28: "However, the ... al., 2015)." Rewrite the sentence such that it reads well and that it is clear if you made up a statement yourself or it is based on a reference.
- Introduction (7027), Line 3: Specify this is the Sierra Nevada in the US (and not Spain, or Colombia).

- Line 7: Unclear what a “longer memory effect" exactly means. It is important to make this clear as this is also mentioned in your objectives of the study.
- Line 16: what about spring precipitation?
- Line 17: I do not see how you look at their spatial influence. Do you mean between catchment differences?
- Lines 18-19: I don’t think this statement is very clear “To explore ... amounts overall". Why is this more important here?
- Study area, Lines 25-26: What do you mean by “as close as possible to natural conditions". Does this mean there are no land-use changes? Does it only refer to dams in the river?
- Page 7028, Line 22-24: Be more specific in what Jorg-Hess et al. (2014) already did regarding the link of SWE and low flows.
- Page 7029, Line 12: Clarify why you chose this set of predictors. Maybe it is very obvious, but you currently do not explain your choice
- Line 26: why did you set the threshold at 1.1C? Is this based on another study? Does the threshold affect your choice?
- Page 7031, Line 2: What do you exactly mean by “is more obvious"
- Page 7032: Section 3.1: be explicit which results of the table you use to make these conclusions.
- Page 7034: Section 3.3 Explain why you use these three catchments?
- Discussion section: the discussion of the sensitivity to climate change is really short and does not include any effects different expected SWE changes between

the different altitudes. In lower elevation catchments the % of SWE is much more sensitive to temperature changes, than high elevation catchments. This needs to be emphasized. Also, a statement as “This reduction might increase problems with water availability in affected regions" is not really helpful if you do not provide any numbers of changes you expect with for example a 2 degrees warming.

- I don’t learn anything from the the discussion section on “Combined effect of snow and precipitation".
- Maybe to my ignorance but I do not understand the argument of using SWE since you don’t have groundwater data “Snow melt ... minimum discharge (Fig. 2)"
- 7039, Line 11: Be more specific than “significantly affected low flows". Does it change the volume of low flows, the timing of low flows or both?
- It is unclear if the statement “Low flows occurred later in the year for years with above average snow accumulations. A decrease of maximum snow accumulations by 100mm resulted in earlier runoff minima by 12 days" is applicable for all catchment?
- Line 20-24: “Snow and . . . were considered." It is unclear if the combination of rain and snowpack can sufficiently explain low flow conditions or if more information is needed.
- Figure 1: Does it make sense to also have the altitude differences in Switzerland indicated on the map?
- Figure 2: I doubt this will be readable when printed on a A4 format.
- Figure 4: How do you explain the significant negative correlations?
- Figure 6: Make clear what the reference date is on the y-axis.

- Figure 8: Are the labels of this figure readable when printed on A4 format? Can you provide a color-scale for the elevation indication?

References

- Tague, C., & Grant, G. E. (2004). A geological framework for interpreting the lowâĂŘflow regimes of Cascade streams, Willamette River Basin, Oregon. Water Resources Research, 40(4).

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 7023, 2015.