

Interactive comment on “The importance of glacier and forest change in hydrological climate-impact studies” by N. Köplin et al.

Anonymous Referee #1

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This well-written manuscript analyzes the hydrological effect of glacier retreat and forest cover modification in response to climate change. The impact analysis is based on the ENSEMBLES project climate projections and studies the effect of different glacier retreat and forest cover increase scenarios on 15 mountainous catchments in the Swiss Alps. The impacts are assessed in terms of annual runoff as well as in terms of its distribution throughout the year. From my point of view, this "classical" impact study (injecting a number of climate and land use scenarios into a rainfall-runoff model) lacks a critical view on the value of such studies in general and does not sufficiently discuss the results with respect to existing literature.

Detailed comments

- The literature review in the introduction seems to be incomplete; while it might be possible that there are no previous studies that compare forest cover and glacier cover scenarios in the context of climate change, there are studies that analyze the one or the other for high mountainous contexts (e.g. Stahl et al., 2008; Huss et al., 2008; Huss et al., 2010; Horton et al., 2006; Finger et al., 2012; Zierl and Bugmann, 2005). They should be reviewed and the methods / results critically be reflected. I also recommend reformulating the last sentence of the introduction, which talks about land use in general whereas it should refer to glacier and forest cover.

- Observed fluctuations of forest cover in the Alps: at p. 5986 it is simply stated that forest cover increased at the end of the last century and that this was for an important part due to land use. It would be interesting to have more details here (what caused the increase?), especially since increase of forest cover might be a rather unexpected phenomenon for readers not familiar with the Alpine context (this only becomes clear in the scenario of land abandonment).

- Hydrological model parameterization: the paper does not discuss the implications / uncertainty of model parameterization on the results. Given that most catchments are ungauged (p. 5988, lines 1-5) and that the model parameters had to be regionalized, it is highly probable that parameter uncertainty plays a major role here (the model probably has a huge number of parameters since it uses 22 land cover types). What evidence does exist that the simulation results are not just "artefacts" depending on the selected parameter sets and that other equally good parameter sets would not have given very different results? What evidence does exist that the selected parameter sets are useful for present day AND future scenarios? Personally, I think that state-of-the-art climate change impact studies should properly discuss / address modeling uncertainties and not simply state without any further justification that "the most important source of uncertainty (..) is the climate scenario" as in the current abstract (see also Blöschl and Montanari, 2010).

- I do not understand the tree line calculation; does the tree line simple follow the tem-

perature, without any scaling? (100 m of increase of the e.g. 10°C annual temperature line = 100m increase of the tree line)? If yes, this should be said in a clear way (instead of " The increase in tree line was calculated according to the average temperature lapse rate of 0.56K per 100m")

- The scenarios are designed for comparison with existing studies, but such a comparison seems to be almost absent

- Forest scenarios: scenario 1 corresponds to an increase of the tree line with the expected temperature change but what governs the extend of "forest ingrowth" in scenario 2?

- ANOVA: the scenarios are of "additive" nature, i.e. one scenario includes the effect of all previous scenarios. This means that variance explained by scenario FC3 includes variance explained by FC1. How can we know how much additional variance is explained by FC3? How can you complete a proper analysis of variance in this context? This should be better explained.

- In the current manuscript version, the plots give all the water balance components but there is almost no quantitative discussion of these components (and no table summarizing them), which does not help the reader to have a clear picture of the overall changes.

- ANOVA results analysis: the text states in 4.3 that "the interaction term is rather small which indicates independence of the scenarios with respect to the considered target variables." This seems rather strange, the glacier retreat scenarios depends on the climate, the same holds for the first forest cover scenario. What explains this independence?

- p. 6002, line 1-2: something seems to be wrong here ("evaporation (..) comprises (..) evaporation").

-The current and future water balance components are almost not compared to pre-

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vious studies; on p. 6003, line 17 the results are said to be in line with results from Hundecha and Bardossy and Fohrler; both studies apply however to low mountain ranges and do not just analyze forest cover change; the relative importance of glacier retreat and forest cover change are compared to the study of Cuo et al (p. 6003, line 24) who analyzed an estuarine catchment in the US (i.e. with a rather different hydro-meteorological context). I would have expected here a more in depth comparison to results from the Alps.

- At the same location in the manuscript (p. 6003 / 6004), there is the very general comment that climate change is the most important source of uncertainty; which part of the study analyzed this uncertainty? Reference for this statement are two studies in the UK, which are not of direct relevance and one in Switzerland. Please refer here to recent studies from the Alps

- p. 6004: " Evapotranspiration, on the other hand, is of minor importance in this region": as far as I can see, for catchment 4, the future scenarios has 1350 mm of total precip. and 450 mm of evaporation. This seems to be a contradiction with the above statement. A table summarizing the water balance components for all catchments would certainly be helpful (perhaps as suppl. material).

- p. 6005, line 5: "we question the frequently proposed strong interactions of climate and land cover, at least for the studied climate region"; what is the purpose of questioning the interaction of climate and land cover here? of course, the selected climate simulation conditions the glacier cover; the forest scenario 1 is driven by climate!

- Conclusion (p. 6005, line 25): which part of your study analyzes the effect of using an ensemble of climate simulations rather than a single simulation? are there results referring to this? furthermore: what do you mean by "assess the impact on lower and higher hydrograph quantiles?" on extreme values?

- Fig. 4: I like the idea of visualizing the scenarios but I find the upper right side difficult to understand

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- Fig. 5: this figure is too dense; having temperature, PET, ET, SME and P, for control and future median climate, and for the forest scenarios, in a same plot does not help the reader to actually see what is going on here. I suggest to regroup similar plots with similar symbols in a new figure (1 plot for inputs, 1 with evaporation and soil moisture, 1 with runoff and runoff coefficient). By the way: since the graphs are too dense, things that are said in the text cannot be seen (e.g. " In July and August, even a slight decrease of actual evapotranspiration is observed")

- Fig. 5: the input part shows liquid precipitation as well as solid precipitation and snow melt. This accounts twice for solid precipitation (since snowmelt was solid precipitation before); the plot should show actual liquid input to the system (melt and rain) OR total input to the system (precipitation + glacier melt if there is)

- Fig. 6: the inputs should also include ice melt

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