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Discussions

Interactive comment on "Elevational dependence of climate change impacts on water resources in an Alpine catchment" *by* S. Fatichi et al.

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In addition to my summary of the discussion of the HESSD manuscript, I would like to add a few detailed comments:

1) **Literature review**: There are numerous simulation studies for this catchment but they are not all published in peer-reviewed papers, please refer namely to (Hingray et al., 2010;Tobin et al., 2012;Mezghani and Hingray, 2009). Hingray et al. (2010) discuss in detail how to calibrate a semi-distributed model for this catchment for design flood estimation but without modeling explicitly the hydraulic infrastructure. All the work related to the Minerve project (García Hernández et al., 2009) is based on a distributed model of the entire Upper Rhone River basin including the hydraulic infrastructure.

The literature review should certainly refer also to previous hydrological studies of this catchments even if they are only published in engineering journals or in PhD theses. You might want to check (Bérod, 2013) for an overview and the theses of (García Hernández, 2011;Tobin, 2012;Mezghani, 2009).

2) **Gridded meteo data - temperature?**. As far as I can see this is one of the first hydrological modeling studies making use of the gridded data of MeteoSwiss RhiresD. Given that apparently this product is very useful for hydrological modeling, it would be nice to have it mentioned in the abstract and the conclusion. It could also be useful to mention that it is freely available for research. Is there not a similar product for temperature? Why was it not used? And why does the study work with a generic temperature lapse rate rather than with a temporally and spatially distributed lapse rate? It is well known that the lapse rate plays an important role for hydrological modeling in this kind of environments (e.g. Tobin et al., 2011). Why is this not part of the meteo generation framework? Especially when it comes to extreme events simulation, the temperature interpolation and its effect on snow accumulation, snow melt and rain on snow effects cannot be neglected.

3) **Unnecessary details?**. I do not see the interest of including details on water consumption and irrigation if there is no information about it and if it does not have any effect on the reported results; if these aspects are included because the framework project required it, there is still no need to discuss this in the present paper.

4) **Study area**. What is the mean elevation of the catchment and of the control points of table 1? Why did you not use the Swiss land use data? There should be proper references to all used products (with details on publisher and related webpages, e.g. also for the Swiss Committe on Dams and all maps).

5) **Target-level water management policy**. The selected approach is certainly useful for the present day situation even if I think that there is only one target level for a short temporal window (the only objective is the filling of the reservoir by end of summer

(Schaefli, 2005)). In exchange, I do not understand how this rule can be applied to the future scenarios; were the target-levels recomputed for new reference periods? If the target-levels remain the ones of the present-day, how can the dams release any water through the turbines if the dam level is permanently lower than the target during the summer? The definition of the target levels for the future period should be clearer. I think that there would have been simple strategies to come up with new management scenarios; looking at recent hydropower lake filling curves for Switzerland, it is obvious that during some recent years, the behaviour of the dams was quite different from the past, this might have allowed to build scenarios (see the Swiss Federal Office for Energy, http://www.bfe.admin.ch/, look for "Water levels of reservoirs").

6) **Model performance**. It would be useful to clearly state in the paper that the good Nash values are essentially due to the hydrological regime (as discussed in an answer to a reviewer comment). It could also be useful to cite (Schaefli and Gupta, 2007). In fact, Nash values of 0.8 are already not very good for this kind of regimes with a strong annual cycle. This reinforces my critical view of the extreme event analysis. Furthermore, the Nash values for the different sub-catchments are not comparable to the ones of the Rhone river; the stronger the annual cycle, the higher the Nash values even for a "bad" model. (For this case study, it would have been useful to think about a hydrological performance measure that is not influenced by the hydrological regime but this is certainly beyond the scope).

7) **Discussion**: p. 3768, line 21: this sentence seems to imply that the hydraulic infrastructure had an effect on the hydrological budget; I would reformulate to reflect that the hydraulic infrastructure only impacts the seasonal distribution of water.

p. 3770, line 20: As far as I know, there are no observed floods in spring in this catchment and its subcatchments (but my analysis dates back to 2005). It is, in fact, difficult to say whether there are no spring floods or whether any spring floods would be absorbed by the empty accumulation lakes. It would be interesting to know whether this is a general statement (in this kind of regimes, spring floods are to be expected),

whether it is based on observed data or on simulation without hydraulic infrastructure. Please also include the following reference here: (Bieri and Schleiss, 2012).

p. 3771: "We We argue that even with a different management of the dams, the total energy production of the control scenario would be unlikely maintained in the 2030–2050 period". This is a very strong statement and I would argue that it is wrong: there is at present more water available in the relevant sub-catchments than what can actually be stored in the lakes. The lake of Mauvoisin (which I know best) could be filled 1.3 times every year (see Schaefli, 2005, the lake volume is $204 * 10^6 m^3$, the annual runoff from the catchment is $265 * 10^6 m^3/yr$). Furthermore, water repumping will become standard in most hydropower systems. Accordingly, there is no reason why the total energy production might not be maintained in the future with new management strategies.

8) **Minimum flow requirements**. In Switzerland, there is an important ongoing discussion on the minimum flow requirements and whether they reduce the hydropower production potential. The present study offers great potential to answer some important questions in this field (interaction of flow requirements and climate change). It would have been nice to see something in this direction.

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