Response to the report of the anonymous reviewer #2

1 Paper Description and General Remarks

The authors investigated the sensitivity of 24 Swiss catchments to meteorological droughts. They constructed two drought scenarios: the first was a modest but constant progression of drying based on sorting the annual precipitation amounts; the second was a more progression of drying based on selecting months from different years to form complete years with the wettest to years with the driest months. The two scenarios are said to retain the intra-annual variability. They deployed the conceptual semi-distributed HBV rainfall-runoff model for their experiments and report varied reactions of catchments to the meteorological droughts showing low levels of streamflow and ground water. In all the studied catchments, they found that mean elevation, slope and size were the main controls on sensitivity of catchment discharge to precipitation: catchments lying at high elevations and having steeper slopes showed less sensitivity to meteorological droughts. Climate change is very important at the present and efforts to improve our understanding of the underlying processes and the probable effects on humanity are highly welcome, thus the relevance of the research. However, I have some remarks that are outlined below.

I could not follow the authors' arguments on many occasions. I propose they streamline their reasoning to eliminate ambiguity.
We agree that there are several statements and formulations in the article that have to be clarified to avoid misinterpretations. We will carefully address this in a revised version.

The studied scenarios assume progressive future reductions in precipitation, something that is not true everywhere at least not in central Europe (see e.g., Dai (2011)). By the way, 35 years of continuous drying seem unreasonable. It would add credibility if the results from the experiments could be compared to results performed with an observed dataset.
The scenarios that were used in the study were not designed to meet realistic conditions and we are aware of that it is unlikely that there is a continuous progressive drying for 35 years. The main idea of developing this method of applying a progressive drying was to see the sensitivity of different initial conditions (dry follows drier) and the different reactions of the catchments to the different initial conditions.
However, the precipitation that was used for the simulation was not unlikely for the specific seasons, as it was actually observed in the past.

Secondly, the different catchments should react differently to forcings but the authors do not mention the years when the various catchments were under drought. Apart from the summer drought of 2003 falling within the simulation period (the selection of which could have been motivated by data availability considerations), what else qualifies the event as representative?
The summer of 2003 was an event that was affecting all of the catchment of this study and it is mentioned as the summer drought that could be expected in the future (Schär, 2004). The event of 2003 is qualified in fact by the period in which it falls, motivated by data availability. For several catchment also the drought of 1976 would have been available but not for all. To include as many catchments as possible for inter catchment comparison we decided to take only 2003 as an example. We will clarify our motivation in a revised version.

A sustained reduction in precipitation would have an impact on temperature: there would be less water to evaporate, thereby an increase in the air temperature and thus an amplification of drought severity (see e.g. Trenberth et al. (2014)). Sheffield et al. (2012) studied the combined effect of reduced precipitation and increased temperature and decoupling the two might be an oversimplification. Much as that might be beyond the scope of the current work, I would have loved the authors to state, at least speculatively how their chosen scenarios impact the energy balance and ultimately the partitioning of soil moisture.

It is true that there might be feedback that could not be considered in the simple approach taken. However, we did not de-couple the observed temperature and precipitation as we used the temperature and precipitation record that was observed at a certain time and did not split them. We will add some discussion on this important point in a revised version.

It is possible that the scope of the experiments was not sufficient for all the conclusions to be drawn. Specifically, I'm not convinced that the subsurface properties do not have any bearing on the groundwater storage. I also find issues with the way the authors remained silent on the changes in land cover (or land use) over the simulations period.
We agree that the subsurface should have an influence and we saw it in the example of 2003 that the modeled subsurface storages of different catchments reacted differently. However, we did not find a relation to the simple hydro-geologic measure that we derived from hydrological maps. We will clarify this in the revised version.
Regarding the land cover or land use change over the simulation period, we indeed did not consider this. Our approach was looking at the sensitivity of catchments to the continuous drying. We assume that e.g. trees would respond to the continuous drying and of course this would affect evapotranspiration rates and runoff behavior. As in the comment above about feedback related to different temperatures, we will add discussion on this point. It should be kept in mind, however, that also in many other scenario studies there is no change in vegetation included but only the response to decreased precipitation or increased temperature analyzed. In addition, land use changes in the last 40 years in Switzerland in the selected catchments were very moderate, since we selected headwater catchment with a low proportion of urbanization.

2 Specific Remarks

P7661, L14 ...sensitivity of course results from... modification by specific catchment properties. It is rather counter-intuitive that hydrogeological catchment characteristics have no effect at all on groundwater droughts. Could it be possible that the experiments conducted are not adequate for such a conclusion to be drawn.
See discussion above.

7661, L15 Please write an individual instead of a individual.
Ok.

P7661, L26 Please insert a comma after Further.
Ok.

P7666, L6 Please consider rewriting the sentence as Δx was calculated using Eq. 2 for ...
(GW+SUZ+SLZ) as shown in Fig. 1. Numbering for line 5 seems to be misplaced.
The groundwater storage used in the study is indeed the sum of the two groundwater storages (SUZ and SLZ) of HBV. The line numbering is generated automatically using the template of HESSD.

P7666, L10 Insert a space before IQR.
Ok

P7669, L11 Please rephrase to ... scenario SoMo always resulted in ...
Ok

P7669, L27 Please change a difference to the difference. I suppose you use talking about flow rating curves and the probability of exceedence here. Since your study is on droughts (low flows), it might be confusing to some people when you speak of days exceeding Q_{90}. I suggest you briefly say something to that effect in order to mitigate the potential source of confusion.

As mentioned in the response to the review to the other reviewer, the switch from days below to days exceeding was done to compare the different measures more easily. We will clarify this in the revised version.

P7670, LL8-17 Can the results presented in Fig. 5 be reproduced when the model is allowed a reasonable spin-up period?
For the results in Figure 5 we already applied a year of warm up, we will make this clear in the revised version.

P7670, section 3.3 The authors state that small, high and steep catchments are less sensitive to drought than large, low-lying and at catchments. Could the authors offer an explanation why this is so and how the sensitivity of large, highland catchments might be? I also expected the changes in land use to be relevant to the evapotranspiration from the catchments. Could the authors say if the land use (or cover) was constant (and if so, why) over the entire period?
See discussion above. We will clarify this in a revised version.

P7672, L9 I think that disregarding the initial wetness destroys the autocorrelation structure of the groundwater signal (long memory effects are known to exist in some regions).
The phrasing was maybe ambiguous and we will clarify in the revised version. The initial wetness was not considered for construction of the scenarios, i.e. there might have been a dry year with a wet end of the year. It anyhow would have been sorted as a dry year closer to the end of the scenario as of the sorting by precipitation means only. Before we ran the scenarios the model was calibrated to observed data (in natural sequence). The modeled storages of the catchments should ideally be sized to represent memory capacity.

P7687 Please make the figures bigger and print the axis labels labels close to the corresponding graphics.
We will work on increasing the readability of the figures.

The authors did not aim to construct realistic scenarios and intentionally removed the natural variability in precipitation. Since some of the results are rather surprising, it might be helpful to perform their experiments with an observed data-set.
The natural variability of precipitation was not removed, neither for the yearly or the monthly scenarios. For the SoYe scenario the years were sorted from wet to dry, however the intra-annual variability as it was observed remained. Also for the more extreme scenario SoMo the intra-monthly variability was actually observed, i.e. its natural climatic regime.

Their arguments were also hard to flow and most of them need reformulating. For these, I recommend a major revision before the manuscript is accepted for publication.

References

Dai, A. (2011), `Drought under global warming: a review', Wiley interdisc. Rev. Clim. Change 2, 45-65.
Sheffield, J., Wood, E. F. and Roderick, M. L. (2012), `Litle change in global drought over the past 60 years', Nature 491, 435-438.
Trenberth, K. E., Dai, A., van der Schrier, G., Jones, P. D., Barichvich, J., Briffa, K. R. and Sheffield, J. (2014), `Global warming and changes in drought', Nature Clim. Change 4, 17-22.

Schär, C., & Jendritzky, G. (2004). Climate change: hot news from summer 2003. Nature, 432(7017), 559-560.