General impression

Botter et al. examines in the manuscript 'Anthropogenic and catchment characteristic signatures in the water quality of Swiss rivers: a quantitative assessment' the dataset of the Swiss National River and Survey Program (NADUF). The dataset consisting of biweekly water samples collected in different catchments throughout Switzerland, which were analysed on wide range of different chemical variables. The authors represented the different variables of eleven catchments as boxplots, regime type, variability index, temporal representation and concentration-discharge relations to infer and generalize the impact of catchment characteristics and human activities. The separation of the data into low and high flows gives a new view on the data.

The manuscript is structured but contains some inconsistencies, is sometime not clear or confusing. Definitions need to be better explained, e.g. anthropogenic, human influence and intensive and extensive agriculture in the introduction. Findings need to be reported consistently, e.g. section 4.1 phosphorous or silica L250 is coming from fertilizers/humans while section 5.1 and L283 reports that it might be also due erosion or geology. Related to this, chose the appropriate data and analysis to answer the research question.

Not coming from Switzerland, it is hard to understand where the metropolitan areas are, which kind of land use and land cover or geology the different catchments have and how this affects the water quality. Therefore adding such information in Figure 1 will help to interpret the data, e.g. why certain catchment have higher Ca, NO3 or DOC concentrations compared to others.

In addition to the defined objectives, it might help to phrase a clear research question and state which the different hypothesis are. This will allow to distinguish between different processes and the complex interaction of climate, catchment characteristics (land use and land cover, geology, topography, shape…) and humans affecting stream chemistry. The influence of climate forcing on chemical variables was only vaguely discussed and not supported through any analysis, but it is required in the next version.

The number of figures in the main article and supplementary material is overwhelming. By refereeing to both main article and supplementary material, results in that the reader get lost and forgets about the main findings. Figures contain lots of information, but the results are not equally explained for every figure. With regard to the figures, I suggest moving important figures into the main article and leaving "less" important ones in the supplementary material. To decrease the number of figures and focus on the main findings different figures could be combined, e.g. Figure 2 and 10, leave out Figure 3 (almost similar information as Figure 4?) and combine Figure 5 and 7.

In the presented work, a subset with consistent temporal data was used. However, it would be unfortunate to exclude how the stream chemistry changes in space. The full data set could be used to perform an additional spatial analysis to infer at which scale the effects of climatological forcing, catchment characteristics and human influence can be detected.

It is necessary to correlate the chemistry with other variables than agricultural land use as land cover, geology, urban area etc. To strengthen the findings it is necessary to perform a comparison between variables and catchments and test whether the findings of Figure 4, 6, 7 and 9 are significant different. In addition, to be able to judge the validity of the results and limitations of the dataset, it is necessary to consider measurement errors and detection limits of chemical variables.

The discussion and conclusion sections are wordy, without highlighting the new findings. To explain the data, different streamflow generation and runoff processes were hypothesized to occur. However, the discussion section lacks debating the temporal sampling interval and its ability describe potential occurring processes at shorter time scales. In addition, it is necessary to refer to the current understanding of streamflow generation, runoff processes and stream network connectivity observed around the world. But also studies from Switzerland, which is known as a country to have a long, history and good knowledge of detailed small-scale catchment processes understanding (from lowlands to Alpine regions), needs to be included. The authors need to revise this section and including these points to be able to put findings into a spatial and temporal perspective.

The manuscript will benefit by streamlining the discussion and conclusion with focus on the effects of climatological forcing, catchment characteristics and human influence on the spatial and temporal variability of chemical variables. It would be also valuable to add a discussion section, from a hydrologist – scientific point of view with an outlook for potential next steps or a critical note on the data collection and what could / should be done differently to address certain future questions.

Specific comments referring to line

27	"*Both natural and anthropogenic factors impact...* " If this is the case, it is necessary to perform an appropriate analysis to separate the different factors.
36, 52	"… *residence time…*" residence times are usually calculated using conservative tracer which is not part of this study. Please clarify.
51	If the catchment structure is important did you test for this?
94	Please clarify the focus of the study, is it human or anthropogenic. How do you distinguish between human and non-human influences?
100	In the table, please indicate the start and end of the available data of the different catchments. What is the impact of the length of different time series? It could be that different decades where drier compared to others. This could affect the results. Please test and explain.
102-103	Please rephrase "basins" and "*large catchments*". Especially since ER LU are rather small catchments.
109	Here you could highlight the long-term character of the data.
116-119	This section is general. Please be more specific and refer to figures.
117	Please explain what "anthropogenic pressure" is.
120	In the discussion section please discuss how the temporal sampling could affect your results. If these samples are long stored, could reactive processes alter the sample and affect the results? Please comment on this.
130,222,250	Phosphor but also other variables could be also due to weathering. Please comment on this.
134	Why are these variables available and not shown or used in the analysis?
147	Please explain why this classification was used and not a classification based on the regime type, precipitation, geology, or land use.
148	Is there a different term for hybrid catchments? It sounds like a mythological creature.
149-152	This sentence is a conclusion. Please move in the appropriate section.
203	Please explain these ratios.
219	Whys is this not surprising? Please explain better or rephrase the sentence.
230	*"…seasonality of streamflow Swiss Plateau catchments is determined by a combination of precipitation and snowmelt."* Isn't this the case in pre and or Alpine catchments? Please explain.
249	*" … there are factors…"* which factors please specify.
307	*"Solute export across catchments seems to be mostly controlled by anthropogenic factors rather than by catchment characteristics."* None of the analysis supports this conclusion! Please perform an analysis, which separates the effect of climatology, geology and human.
313-314	How representative is such a ratio for agriculture seen ratio of the plateau catchments and e.g. LU is similar? Please comment on this.
316	This statement needs to be better explained. What are the differences and which other analysis were used?
319-320	Please provide a back of the envelope calculation to support this statement.
324 -327	Consider moving Figure S1 into the main document to show the signal.
	Please explain the definition low intensive (one cow) vs. high intensive (several cows?). In winter cattle is kept indoors while in summer outdoors. Can you observe this in your data?
	If processes overlap, how is it possible to distinguish from dominant processes and natural vs. human processes? Please comment on this.

L330-331 Please clearly state the difference between agriculture and human activities. Also, in terms of the type of signal one could expect.

333-338 This section is not clear. Please guide the reader through Figure S2. In which way does the coefficient de Pardé of discharge and loads relate to each other? Please explain.

354 Throughout the document it is necessary to clearly state what are areal sources e.g. cities, point sources e.g. Water treatment plants, line sources e.g. streets and what the implications are on the chemical signal. This because data at the catchment outlet might not be representative for all of the catchment. Please discuss this critically.

363 If this figure is important and discussed, it should be in the main manuscript. It would be also interesting to add a "natural" catchment to show the difference between pristine and human influence catchment.

367-370 This sentence is not clear, what are secondary effects. Could a Ca/Mg ratio be useful to show whether the effect is really from fertilizers and not from weathering? It also is necessary to provide data on what would be a natural background value and what could additionally come from fertilizers.

378 This seems a hypothesis and not supported by your analysis.

379 386 By including a geology map and other catchment characteristics will reveal which catchments are affected and by which percentage! Please add and comment.

387 This sentence is not clear, phrasing and hydrological processes. Atmospheric forcing causes also a temporal variability in steep and flat catchments. Please comment / explain.

389 Also in bare fields, soil erosion can be high. Can you see this in the data?

396-414 This section is not clear. In the "alpine" categorized catchments, not every catchment has a glacier. Please comment and explain. This is where global and local runoff processes understanding need to be added.

420-426 I believe that lakes dampen the signal, but where is the analysis to support this statement? In addition, how do other processes, e.g. instream processes, change the signal of interest?

396-414,438-443 Including recent findings on streamflow generation and runoff processes (e.g. America, Europe and Japan) might help to explain the different signals and improves the discussion.

476 Please define what low-flow is. Does this differ among catchments and how does it affect concentrations. Please comment.

496 Why are the atmospheric forcing and catchment characteristics less evident? Based on what? Please explain and rephrase.

499 Despite this spatially rich dataset, how many samples e.g. catchments would one need. What is the effect of scaling in your signal and how would this effect your results - macro pattern vs. micro pattern?

Table 1 In the caption there is written north-south gradient. Is this gradient geographically or rank in the table? Please clarify. Maybe change in the header row the names to - mean annual precipitation and mean annual discharge?

Figure 1 To better link the different catchments use a consistent color scheme as in figure 6

Please add basic information such as scale bar, north and legend.

Also, add information on land cover and land use and large cities, geology and country names.

It is difficult to see where lakes are and why streams, crossing the Swiss borders , are not represented.

Figure 2 To help the reader please specify in caption what *b* and q50 means.

Figure 3 Why do some variables have species in their name and other not? Maybe add also the CV to compare different chemical variables. Due to similarities with figure 4, this figure could be removed.

Figure 4 Give boxplots same color of catchment classification used in figure 6.

Which catchment is **WM**? In Figure 1, this catchment is not visible and might be a typo?

In d) one could argue on an existing decreasing trend with decreasing percentage of agriculture. This due to e.g. outliers e.g. BR-HA where after the information seems to flatten out. Please provide statistical test and in addition, a significant test to compare the different catchments and support your statement.

In addition, is there a real difference in the light of measurement accuracy?

Generally, are these concentrations and their variability high or low? Maybe compare the concentrations with observations elsewhere and report in the discussion.

Figure 5 Why the different streams were clustered according to a hydrological regimes classification? Do the different regimes really cluster e.g. only Inn and Rhine seem to be similar regimes but others not. Please explain.

Caption: "*Each point represents the monthly average discharge* …" should not this be a ratio as described in the y-axis?

"*Hybrid catchment*" Maybe choose a different term.

Figure 6 Please be consistent with the terms. Is it index of variability or variability index?

"*…discharge variability per catchment.*" This should be per catchment class.

Rank the catchments as classes similar to Figure 5.

Next to referring to section 3.2, please explain shortly the patterns and add a legend.

Figure 7, 262 Please better explain in the result section the signals and processes.

The y-axis should be labeled as mean monthly concentration.

Why was only the station at Rekingen shown? It would be interesting to see other catchments Alpine vs Urban influenced catchments and compare the change in amplitudes or signals.

Figure 9 Please add labels to each plot a-d and specify which line is which catchment.

Right panels) Why was only the station at Rekingen shown? It would be interesting to see other catchments Alpine vs Urban influenced catchments and compare signals.

Figure S1 The labels and captions are not coherent and make it difficult to understand. Please change and double check all figures.

Figure S2 …" *Monthly average of discharge…*" The caption and y-label are not coherent and confuse the reader.