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Interactive comment

Interactive comment on "Predicting probabilities of streamflow intermittency across a temperate mesoscale catchment" *by* Nils H. Kaplan et al.

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Interactive comment on "Predicting probabilities of streamflow intermittency across a temperate mesoscale catchment" by Nils H. Kaplan et al. Anonymous Referee #1 Received and published: 24 June 2020 General comments: In "Predicting probabilities of streamflow intermittency across a temperate mesoscale catchment," Kaplan et al. explain the local and accumulated catchment controls on flow intermittence along the flow network of the Attert catchment in Luxembourg. Using logistic regression models for annual as well as wet and dry periods, the authors evaluate the variable importance of land cover, road density, soil, geology, and terrain metrics in controlling flow intermittence. The authors use a unique, empirical high spatial and temporal dataset (Kaplan et al., 2019) to develop these models. The authors presentation of model re-

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sults and discussion of implications and uncertainties is fairly robust but with several opportunities for enhancement prior to publication. In addition, there are grammatical and tense errors and inconsistency throughout, so the manuscript needs detailed proofreading prior to publication. This study is an important scientific contribution with high scientific and presentation quality Dear Referee, Thank you for your helpful comments and questions to our manuscript. We are happy to see your positive summary of our work. Please find your questions and comments marked as e.g. « R1.C1: question/comment» followed by our answer marked as e.g. R1.A1: below. Best regards, Kaplan et al.

«R1.C1. General comments: [. . .] there are grammatical and tense errors and inconsistency throughout [. . .] »

R1.A1 Thank you for pointing this out. We will make sure to do another thorough correction of the manuscript.

«R1.C2. Specific comments: Introduction does a good job of describing prior work and science gaps in the field of hydrology relevant to studying drivers of intermittent flow occurrence as well as spatially mapping it. Good review of logistic regression approach for mapping streamflow presence and absence. - Introduction would benefit by discussion of how streamflow intermittence varies by stream order in arid vs humid locations »

R1.A2.

We will add the following sentence to the introduction at page 1, line 26: These streams are largely controlled by the climatic conditions with generally low but spatially highly variable precipitation as well as high rates of direct evaporation and evapotranspiration through plants (Datry et al., 2017). However, in temperate regions the occurrence of intermittent streams is commonly limited to headwaters, and the wetter climate generally provides enough overland flow and groundwater recharge to maintain perennial rivers for large parts of the river system (Jaeger et al., 2017). These intermittent streams in temperate regions have only recently gotten more attention [. . .].

References update: Datry T., Bondana, N. and Boulton A.J.: Chapter 1 - General introduction. In: Datry T., Bondana, N. and Boulton A.J.: Intermittent Rivers and Ephemeral Streams – Ecology and Management. Academic Press, doi: https://doi.org/10.1016/B978-0-12-803835-2.00001-2, 2017.

Jaeger K.L., Sutfin N.A., Tooth S., Mechaelides K. and Singer M.: Chapter 2.1 – Geomorphology and Sediment Regimes of Intermittent Rivers and Ephemeral Streams. In: Datry T., Bondana, N. and Boulton A.J.: Intermittent Rivers and Ephemeral Streams – Ecology and Management. Academic Press, doi: https://doi.org/10.1016/B978-0-12-803835-2.00002-4, 2017.

«R1.C3. Specific comments: Authors asssert that climate variables constant throughout catchment, so the authors can focus on geological and pedologial factors, but is this proven? pointed to another paper Pfister et al. (2017) for major assertion that climate does not significantly vary across the catchment, better to include figure in paper showing this. »

R1.A3.

To show that rainfall variability is not a major control in this catchment we will add two figures to the supplement. On the one hand the rainfall maps, and on the other hand local rainfall plotted against the local residuals of the statistical models (at the measurement points).

Full caption Fig. S2:

Figure S2: Cumulative Precipitation distribution in the Attert catchment for the annual period July 2016 to July 2017 (a), the wet period (February to April, (b)) and dry period (June to August, (c)). Note: wet and dry here refers to discharge, not to rainfall input. Precipitation data is interpolated with ordinary kriging from site specific local precipitation data (black stars). Precipitation data was provided from a precipitation modelling approach by Neuper & Ehret (2019) which combines weather radar and ground-based precipitation data. The deviation between observed and modelled intermittency is plotted for the corresponding periods.

Figure S2 shows a trend of the precipitation decreasing from North/North-West to South/South-East. This trend shows a difference in annual precipitation of about 100 mm which is around 25% of the maximum precipitation sum. The wet period turned out to show lower precipitation sums than the dry period, possibly due to a rainfall data gap of one week and the wet period being 3 days shorter than the dry period. The absolute difference between the minimum and maximum precipitation in the wet period is only 17mm (25% of the maximum). During the dry period the difference in precipitation between driest (130mm) and wettest (195mm) regions amounts to 33% of the maximum. This trend is roughly reflected by the geological setting. The North/North-Western part of the catchment comprises the highest ridges of the catchment with slate geology. The precipitation in this part of the catchment is higher through the orographic uplift at the ridge, whereas the lower areas of the catchment (mainly the geologies of marls and sandstone) lie in the rain shadow of the Ardennes (Neuper & Ehret, 2019). However, the precipitation sums do not reflect the runoff behavior in the corresponding periods. The wet period shows lower precipitation sums compared to the dry period. This indicates that evapotranspiration is a stronger control of runoff in the catchment, which is also stated by Wrede et al. (2014). On the other hand, ephemeral streams which are controlled by intense precipitation events are not necessarily dependent on the precipitation sums during a specific period, but stronger linked to the precipitation intensity during a single event (Datry et al., 2017). The residuals between observed and modelled intermittency cannot be explained by the precipitation patterns (Fig. S2 and S3), which confirms our assumption that rainfall patterns do not need to be included as a predictor in the context of this study. However, we will investigate the dynamics of patterns of intermittency and their dynamic controls in a separate study.

We will provide a reference to the supplementary Figure S2 in the main manuscript on

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page 4 line 20: "[. . .] results in similar climate conditions across the catchment (Pfister et al., 2017, Fig. S2)."

We will also provide a reference to the supplementary Figure S3 in the main manuscript on page 22 line 13: [. . .] which is supported by the small differences in annual precipitation (Pfister et al., 2005; Wrede et al., 2014, Fig. S3).

Reference Update in Supplements:

Neuper M. and Ehret U.: Quantitative precipitation estimation with weather radar using a data- and information-based approach. Hydrol. Earth Syst. Sci., 23, 3711–3733, https://doi.org/10.5194/hess-23-3711-2019, 2019.

«R1.C4. Specific comments: I appreciate that streamflow intermittence is not easy to predict. Perhaps including gridded estimates of precipitation at observed timesteps would help improve performance. I expect that this data is available. Could use precipitation on day of flow observation as well as 1 day prior , or 7-day antecedent precipitation for example. The current models of landscape / soil / geology variables are justified, but including climate could potentially improve performance substantially. »

R1.A4.

Using event-based precipitation and the pre-event precipitation as indicator for the wetness of the system is indeed a good suggestion. However, the study at hand focuses on a full year and two three month periods and does not drill down to the event-scale. As the precipitation patterns are unable to explain the spatial pattern of the model residuals we think that at it is a viable assumption to neglect the rainfall variability at this 3-month or annual time scale and to focus on quasi-static landscape controls. The dynamics of intermittency, also at the event scale are being tackled in a separate study.

«R1.C5. Technical comments: Instead of "permanent" term, suggest "perennial" throughout. Also use this instead of "continuous »

R1.A5.

We will use the term perennial as you suggest. This will be possible due to our definition of perennial also for the 3 month period at page 24, line 11. We will keep the term "permanent" at. . . . . .page 26, line 27 because we use it here as the description of the probability range of streamflow. . . .page 2, line 11 because the perennial classification is defined for rivers and not for the baseflow component.

We will keep the term "continuous" for page 2, line 13 as this describes a time period not the annual behavior. We will change the term from "continuous" to "perennial" at page 6 line 26

«R1.C6. Technical comments: Provide additional information on the range in climatic conditions when virtual sites were visited and how exact locations were chosen »

R1.A6.

We will add this section on page 6, line 17: The majority of virtual sites were visited every two months during maintenance campaigns for the monitoring sites. Virtual sites located at the ridge of southern sandstone regions were visited less frequent, but showed no sign of surface flow during all visits. The sites were added to the dataset at locations which were a) frequently visited and thus known to have no-flow behavior and b) also in areas where no-flow observations are underrepresented in the dataset, such as ridges in the sandstone region or the riparian zone of valleys in the slate region and c) the capability of the model would be enhanced.

«R1.C7. Technical comments: relative intermittency of streamflow Ir is analogous to more commonly used "no flow fraction" »

R1.A7.

Unfortunately, our literature search for the term "no flow fraction" for what we called "relative intermittency" was unsuccessful. We would therefore leave the decision if this is the more common term and should be used to the editor: if the editor confirms this, we are happy to change the terminology. However, in that case we would find it helpful

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to be pointed to the publications using this term.

«R1.C8. Technical comments: Clarification of local and catchment variables needed in abstract »

R1.A8.

We will add the following sentence on page 1 line 16: “We used 15 spatial predictors describing land cover, track (road) density, terrain metrics, soil and geological properties. Predictors were included as local scale information, represented by the local value at the catchment outlet and as integral catchment information calculated as the mean catchment value over all pixels upslope of the catchment outlet.”

«R1.C9. Technical comments: Better clarification in abstract of which variables important in which models (annual, wet, dry) »

R1.A9.

We will change the section page 1, line 16 – 18 from:

“The terrain metrics catchment area and profile curvature were the most important predictors for all models. However, the models which include the dry period of the year reveal the importance of soil hydraulic conductivity, bedrock permeability and in case of the annual model the presence of tracks (roads) during low flow conditions.”

To

“The terrain metrics catchment area and profile curvature were identified in all models as the most important predictors, and the model for the wet period was based solely on these two predictors. However, the model for the dry period additionally comprises soil hydraulic conductivity and bedrock permeability. The annual model with the most complex predictor set contains the predictors of the dry period model plus the presence of tracks (roads).”

«R1.C10. Technical comments: Final sentence of abstract: could suggest that the first

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step was the extensive monitoring that was completed using a variety of sensors »

R1.A10.

We will change the sentence to: This approach, based on extensive monitoring and statistical modeling, is a first step to provide detailed spatial information for hydrological modelling as well as management practice.

«R1.C11. Technical comments: Combine first two sentences of introduction »

R1.A11.

We will change the sentence to: “Even though intermittent streams and rivers represent more than half of the global stream network (Datry et al., 2014) they have been studied to a far lesser degree than their perennial counterparts.”

«R1.C12. Technical comments: Figure 5, color bar legend does not match figure caption »

R1.A12.

The color bar refers to the plotted points (color coded). The first sentence in the caption refers to the color bar. The second sentence in the caption refers to the gray boxes in the plot. We will change this sentence to: “The grey boxes indicate the classes of ephemeral ($Ir < 0.1$), intermittent ($0.1 \leq Ir < 0.8$) and perennial ($0.8 \leq Ir < 1.0$) streamflow.”

«R1.C13. Technical comments: First sentence of conclusion, highlight the novelty of this approach as compared to previous logistic regression approaches mentioned in intro »

R1.A13.

We will change the sentence from:

“This study presents a novel approach of modelling streamflow intermittency using logistic regression models with data of streamflow presence/absence and spatial predictors."

to:

"This study presents a novel approach of modelling streamflow intermittency using logistic regression models. In contrast to earlier studies we use the newly introduced response variable of relative intermittency instead of binary streamflow classes (e.g. intermittent/perennial) which allows for modelling of streamflow probabilities. The comparable climatic conditions across the studied catchment permit a focus on quasi-static predictor variables such as geology, soil, terrain, land cover or tracks and roads."

«R1.C14. Technical comments: Conclusion a bit redundant with discussion, suggest focusing on key takeaways »

R1.A14.

We will revise the conclusions thoroughly to improve the focus.

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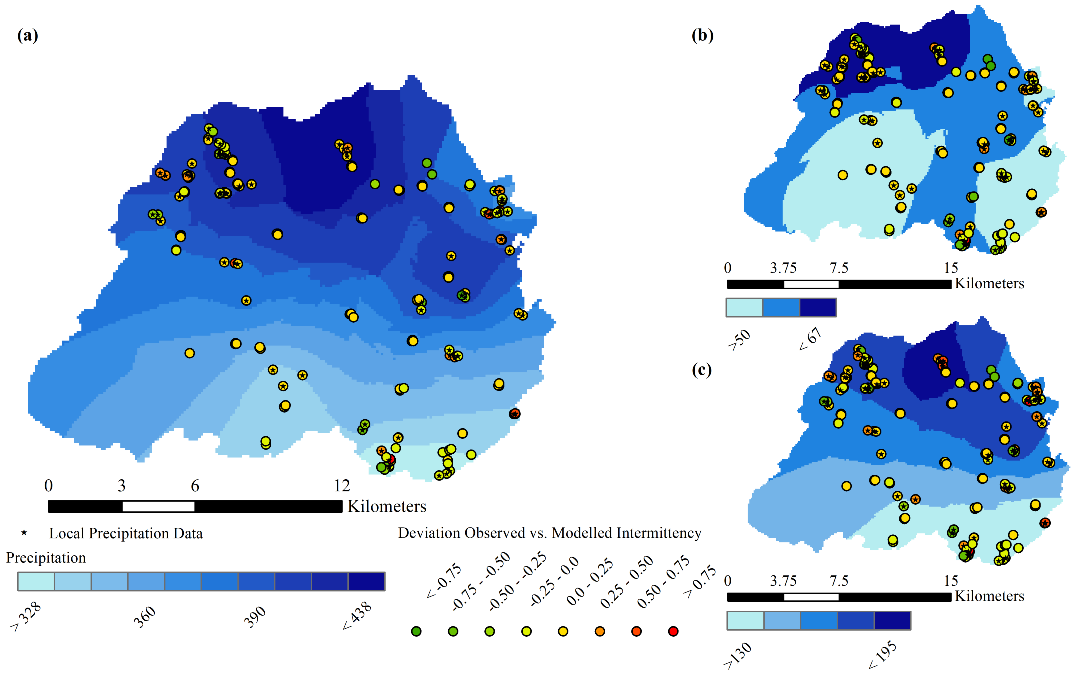

Fig. 1. Figure S2: Cumulative Precipitation distribution in the Attert catchment for the annual period July 2016 to July 2017 (a), the wet period (February to April, (b)) and dry period (June to August, (c)).

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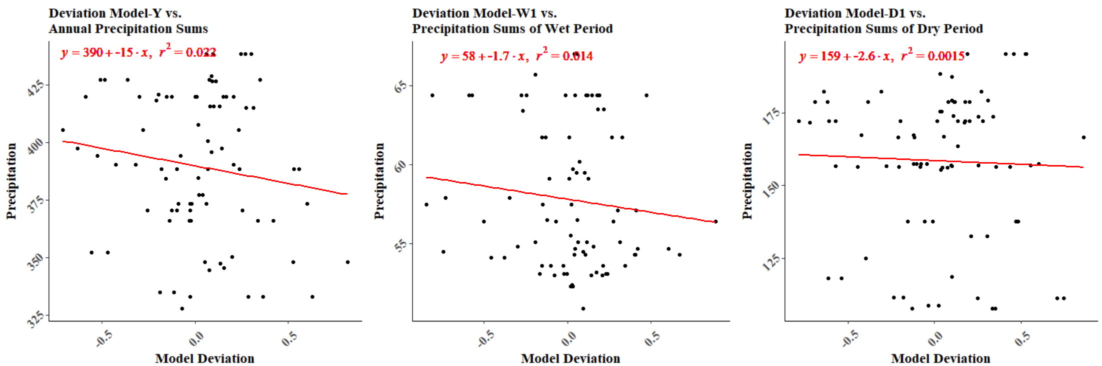

Fig. 2. Figure S3: Deviation between observed and modelled plotted against the corresponding precipitation sums of the modeled periods.

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