Editor Decision: Publish subject to minor revisions (further review by Editor) (07 Jun 2017) by Jan Seibert

Comments to the Author:

Thanks for your efforts with the revision of the manuscript, which has greatly improved. As described nicely and in more detail by reviewer #3, there are still a number of issues which need to be addressed carefully. In particular, you need to better describe the M5 model (or models?) in a way that is understandable for the (hydrological) audience.

M5 model tree is the standard name thus, the plural will be M5 model trees. The text has been checked for coherence.

The explanation has been revised to clarify the process and to avoid duplicities in the used terms. Basically M5 hierarchically divides the input dataset in homogeneous parts such as, extreme precipitation and peak flows or summer low flows (which are likely to be characterized by periods without precipitation), and for each partition a linear model is adjusted. In the end it is a piece-wise linear model with each part dedicated to a particular hydrologic condition.

In Shortridge et al. (2016) this technique is simply described as follows: M5 models are a rule-based, non-parametric regression approach that fits a linear regression model to each terminal node of a regression tree (Quinlan, 1992). M5 models were fit using the Cubist package in R (Kuhn et al., 2014).

Certainly, a decision tree can be read as a set of rules. However such a definition neglects the fact that the dataset is divided in a hierarchical fashion, which has implications in the performance of decision trees (see Grubinger et al., 2014; Muñoz-Mas et al., 2016). Therefore, we advocated the original definition that involves the term 'decision tree'.

We hope the actual description is of sufficient clarity.

Grubinger, T., Zeileis, A., Pfeiffer, K.-P., 2014. Evtree: Evolutionary learning of globally optimal classification and regression trees in R. J. Stat. Softw. 61, 1–29.

Hettiarachchi, P., Hall, M.J., Minns, A.W., 2005. The extrapolation of artificial neural networks for the modelling of rainfall–runoff relationships. J. Hydroinformatics 7, 291–296.

Muñoz-Mas, R., Fukuda, S., Vezza, P., Martínez-Capel, F., 2016. Comparing four methods for decision-tree induction: A case study on the invasive Iberian gudgeon (Gobio lozanoi; Doadrio and Madeira, 2004). Ecol. Inform. 34, 22–34. doi:10.1016/j.ecoinf.2016.04.011

Shortridge, J.E., Guikema, S.D., Zaitchik, B.F., 2016. Machine learning methods for empirical streamflow simulation: A comparison of model accuracy, interpretability, and uncertainty in seasonal watersheds. Hydrol. Earth Syst. Sci. 20. doi:10.5194/hess-20-2611-2016

Solomatine, D.P., Dulal, K.N., 2003. Model trees as an alternative to neural networks in rainfall-runoff modelling. Hydrol. Sci. J. 48, 399–412. doi:10.1623/hysj.48.3.399.45291

Taghi Sattari, M., Pal, M., Apaydin, H., Ozturk, F., Sattari, M.T., Pal, M., Apaydin, H., Ozturk, F., 2013. M5 model tree application in daily river flow forecasting in Sohu Stream, Turkey. Water Resour. 40, 233–242. doi:10.1134/S0097807813030123

As the reference (Quinlan, 1992) is hard to access this description is really crucial. I would also like to see some better motivation on why this particular (type of) model was chosen. What are the advantages (disadvantages) compared to conceptual/bucket-type models (like SWAT, PRMS or HBV), which are otherwise often used in similar applications.

Process-based physical models are certainly the standard hydrological models (Shortridge et al. 2016). However, flexible data-driven machine learning techniques are gaining popularity because they can be based solely on precipitation and temperature (Shortridge et al. 2016) and can be automatized to perform multiple simulations. We selected M5 because it has shown to have skill in modelling daily streamflow (Solomatine and Dulal, 2003; Taghi Sattari et al., 2013), and is sufficiently fast to deal proficiently with larger datasets (Quinlan 2017). In addition, M5 is able to extrapolate while other approaches are not such as random forests (Shortridge et al., 2016) or multilayer perceptron (Hettiarachchi et al., 2005).

These comments have been included within the main text.

Please also get help from a native speaker, some terms just make little sense (future running flows, rear edge, ...), this is very confusing.
The term future running flows has been removed to avoid misunderstanding.

The “rear edge” concept is now better explained to make easier the understanding of the text.

Best regards,
Jan Seibert

Review comments for:

Waning habitats due to climate change: the effects of changes in streamflow and temperature at the rear edge of the distribution of a cold-water fish

By: José M. Santiago, Rafael Muñoz-Mas, Joaquín Solana, Diego García de Jalón, Carlos Alonso, Francisco Martínez-Capel, Javier Pórtoles, Robert Monjo, Jaime Ribalaygua

The subject paper represents a considerable investment in time and resources to assess the impact of climate change on the thermal habitat of a cold-water fish, the brown trout (Salmo trutta), in central Spain. It is an ambitious effort in collecting and organizing meteorologic, hydrologic and stream temperature data. The downscaling and biascorrection methods of the simulations from general circulation models are of satisfactory quality.

Where the work disappoints is in the methods used to develop state estimates of stream flow and water temperature. The artificial intelligence-based method, M5, used to simulate stream flows, is from a 27-year old paper, not readily available for study by reviewers. The description of the method (Pages 7-8) is replete with jargon and very difficult to understand. However, there is little reason to doubt that the authors applied the method incorrectly. In addition, it may well be the case that the results are within the bands of uncertainty that might be expected by applying a more modern hydrologic model. So, while the paper does not make a compelling case for using this method rather than a more modern one, the results are probably adequate for the specific scientific question posed here.

The stream temperature modeling is even less compelling. The regression-based methodology (Eq. 1) is ad hoc and one that has been criticized for its lack of ability to project the effects of climate (Arismendi et al, 2014). The authors incorrectly cite the work of Piccolroaz et al, 2016 in support of their method. Rather than supporting regression methods like Eq. 1 of this paper, Piccolroaz et al, 2016, conclude that "Conversely, performances of purely regression-based or stochastic models are lower" than their model. It is a well-documented finding, however, that stream temperature is highly correlated with air temperature and, as is the case for the hydrologic model, M5, the results are likely to be within the uncertainty bands that would result from the application of one of the myriad models based on the thermal energy budget.

Arismendi *et al.* (2014) concluded that regression models based on air temperature can be inadequate for projecting future stream temperatures because they are only surrogates for air temperature, whereas Piccolroaz *et al.* (2016) argued that the adequacy depends on the hydrological regime, type of model and the time scale analysis. The main objections of these authors to regressive methods arose when they modelled reaches of regulated rivers, but this is not our case. They recommend their models instead of the Mohseni model, but we have modified the last model to be adequate in a wider range of cases, giving information about the rivers by means of their parameters. So, we show that both the Mohseni model and, specially, our modified model implicitly integrates information on other factors, such as geology and flow regime. We have changed the wording of the phrase in the manuscript to avoid misunderstanding and clarify our arguments.

In two new columns in the Table 6, we include the values of two performance indicators: the Residual Standard Error (RSE) and the Nash Sutcliffe Efficiency coefficient (NSE). The high values of the performance indicators (excepting one case –Pirón 5) show that the models are sufficiently competent.

We are aware that the model can still be improved but important advances were made with respect to the models tested previously in the bibliography (Arismendi *et al*., 2014, Piccolroaz *et al*., 2016).

The development and analysis of this data set is noteworthy and worth publishing because of its environmental relevance. The outcomes from analyzing good, large data sets of stream temperature, hydrology and climate are reasonably robust in terms of the type of model being used. Based on this notion, it would seem the conclusions are also reasonable and, hopefully, of use to water resource planners.

The document also has some shortcomings in terms of an editorial nature, however, and would be improved in the following way:

* Have someone proofread it carefully. We are sensitive to the need to correctly transmit our work and for this reason, we have sent it to a prestigious service for review. So, the last version of this manuscript was revised by American Journals Experts (AJE) as shown by the attached certificate and invoice. We hope this will be good enough.

* There are too few statistical measures of outcomes, particularly for water temperature. We have included new performance indicators in Table 6. They are the residual standard error (RSE) and the Nash Sutcliffe Efficiency coefficient (NSE).

* Use a term other than “rear edge” to define the upper range of satisfactory temperatures for brown trout. The rear edge populations were defined by Hampe and Petit (2005) as those “*populations residing at the current low-latitude margins of species’ distribution ranges, being disproportionately important for the long-term conservation of genetic diversity, phylogenetic history and evolutionary potential of species and that their investigation and conservation deserve high priority*”. This is the eroding margin of the range where lineages mix, the genetic drift and local adaptations increase, and

droughts put populations under stress." *Rear edge populations are typically small and so isolated that regional population dynamics cannot easily compensate local extinction events*". We think that the use of the term "rear edge" improves the understanding of the ecological relevance of this zone. It is not the same concept as the upper limit of the thermal range. We clarify this definition in page 2, line 35.

* Explain "future running flows" or use a different term. The term future running flows has been removed to avoid misunderstanding.

* Define "agglomerative coefficient" The agglomerative coefficient (ac) is a measure of the clustering structure of the dataset, as expressed by Kaufman and Rousseeuw (2005). Its value ranges between 0 (maximum dissimilarity) and 1 (minimum dissimilarity). Thus, observed values in this study show high/reasonable structure.

$$ac = \frac{1}{n}\sum_{i=1}^{n} l(i)$$

* Try to use fewer acronyms. We believe that this is a difficult issue that may make reading tiresome. We include a list of symbols, abbreviations and acronyms.

* Table S1 is not referenced in the main document and needs a much better description of what's in it. Table is cited in page-12 line-14 of the previous version.

* Check the references to make certain they are complete. Checked.

References

Arismendi, I., Safeeq, M., Dunham, J.B. and Johnson, S.L.: Can air temperature be used to project influences of climate change on stream temperature? Environ. Res. Lett., 9(8), 084015. doi: 10.1088/1748-9326/9/8/084015, 2014.

Piccolroaz, S., Calamita, E., Majone, B., Gallice, A., Siviglia, A. and Toffolon, M.: Prediction of river water temperature: a comparison between a new family of hybrid models and statistical approaches: Prediction of River Water Temperature. Hydrol. Process., 30(21), 3901–3917. https://doi.org/10.1002/hyp.10913, 2016

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Waning habitats due to climate change: effects of streamflow and temperature changes at the rear edge of the distribution of a cold-water fish

Authors:

José M. Santiago, Rafael Muñoz-Mas, Joaquín Solana, Diego García de Jalón, Carlos Alonso, Francisco Martínez-Capel, Javier Pórtoles, Robert Monjo, Jaime Ribalaygua

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Title: Waning habitats due to climate change: effects of streamflow and temperature changes at the rear edge of the distribution of a cold-water fish
Submission date: April 11 2017, 02:18 pm

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