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Hydrology and Earth System Sciences Discussions

Interactive comment on "A method for low flow estimation at ungauged sites, case study in Wallonia (Belgium)" *by* M. Grandry et al.

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We first want to thank you for your constructive comments on our paper.

General comments

1) Our aim was to develop a methodology to estimate low flows for Wallonia because none existed. This method can however be transposed to any similar region. It can contribute significatively to a better river and water resources management. In addition, we found a relationship between regression coefficients and the return period, which allowed us to develop a model that can be used for any return period, which is important also for managers who still have to decide which return period to consider in function

of the aim of the project they work on. As you proposed, we will rephrase the literature review accordingly and make clear that the innovation is not only the completeness of the method but also the possibility of calculating low flows for any return period thanks to a relationship between regression coefficients and the return period.

2) We will carefully read again the whole text and follow your advice to improve the presentation, i.e. make it more concise and improve the way the literature review is written.

3) a) We used this very classical method for frequency analysis because we preferred a more systematic approach for all catchments, as it is not the main point of the study. The frequency analysis only allowed us to calculate AM7 for different return periods; values that were needed in the next steps of the method. Our method is maybe more tedious and we therefore hope that it gives the same results as any other frequency analysis method. We will however pay attention to cite in our paper the references you mentioned, as other techniques that could be used for frequency analysis. Regarding the danger of overfitting to short samples, we were careful to favour always a pragmatic approach that chooses 2 parameter laws over 3 parameter laws.

b) - We also found the higher performance of the model in validation unusual. One possible cause is that all specific low flows from validation stations but one or two are within the range where the model is best calibrated (0.0004 to 0.0040 m^3/s.km^2 for return periods of 5 and 10 years, 0.0003 to 0.0040 m^3/s.km^2 for a return period of 20 years, and 0.0002 to 0.0030 m^3/s.km^2 for a return period of 50 years). The R^2 of calibration is lower due to extreme observations (outliers). We would also like to clarify that the validation stations were stations for which all criteria were met except the minimal record length of 20 years but only a few years were missing to reach the 20 years for most of them. These stations were spread over Wallonia, we therefore think that the validation sample is representative. We will clarify all of this in the paper.

- We are aware of the lack of fit of the model for extremes, as we mentioned in the article, but we decided to keep these observations as they are part of the data set, and informed that the model is best calibrated between 0.0004 and 0.0040 $m^3/s.km^2$ for return periods of 5 and 10 years, 0.0003 and 0.0040 $m^3/s.km^2$ for a return period of 20 years, and 0.0002 and 0.0030 $m^3/s.km^2$ for a return period of 50 years. These observations correspond to higher specific low flows and there is no reason to remove them, except to improve the fitting. Our data set is already small and removing some stations only to improve the fitting did not seem appropriate in our opinion, as we aimed at developing a method that could be transposed to other regions and used later with a bigger data set (in around 10 years, when more stations will have at least 20 years of record). As requested, please find attached the scatterplot of predicted vs. observed values of AM7 of the stations used for calibration, for the return period of 5 years.

- The R^2 is indeed impacted by the leverage points. That is why we specified that the model is best calibrated in a defined range of specific low flows.

c) We will make sure to reorganise the text, so that the regionalisation comes after the global regression approach as a test of heterogeneity of the Region, and the part about regional models is summarised to the essential.

Specific comments

p. 11588, line 26. The maximum likelihood method was used to estimate the parameters of the distribution laws, while the Schwarz method allowed to calculate Bayes factors. These factors were then combined with prior probabilities to obtain posterior probabilities. These posterior probabilities were then used to classify the distribution laws and select the 3 best ones.

p. 11590. Percolation is defined as the quantity of rainfall that reaches deeper soil layers. It was simulated by the hydrological model EPICgrid which is able to simulate the atmosphere-soil-plant continuum using soil, geology, land use, agricultural practices, topography (MNT) and meteorological data. Percolation was estimated for each catchment using a “capacitive” approach: each soil layer is considered as a tank that

empties when the layer water content is greater than field capacity. For the calculation of the recession coefficient, the method of Lang and Gille (2006) is based on streamflow records. For each catchment, recession periods are first defined according to flow and precipitation thresholds, and by removing overland flow influence. A mean or master recession curve was then constructed using a method based on the correlation method. The recession coefficient is the parameter of this exponential curve.

p. 11592. The approach of relating regression coefficients to return period has not been taken from the literature. We will therefore highlight it more as part of the innovation of the paper.

Section 3.2. The first component is highly positively correlated to precipitation, the area percentage of forests, the slopes, the altitude, the area percentage of soils of the hydrological group B and the recession coefficient. It is negatively correlated to the area percentage of arable lands and soils of the hydrological group A, the summer temperature, Y map coordinate, and the area percentage of urban lands. These results have a real physical meaning. The Southern region of Wallonia, corresponding to lower Y map coordinates, is characterised by higher altitudes and slopes, while soils of the hydrological group A and arable lands are more present in the Northern region of Wallonia where precipitation is smaller and there are also many big city centres. The second component is positively correlated to percolation and the area percentage of soils of the hydrological group D. The area percentage of soils of the hydrological group C, soils that were not mapped, permanent crops and grasslands, the area, the drainage density, the X map coordinate and the potential evapotranspiration are variables which are less correlated to the first two components. They contribute therefore less to the grouping of catchments in regions.

Section 4 and 5. We will take your comments into account and rewrite the discussion and conclusion in a more concise style.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 11583, 2012.

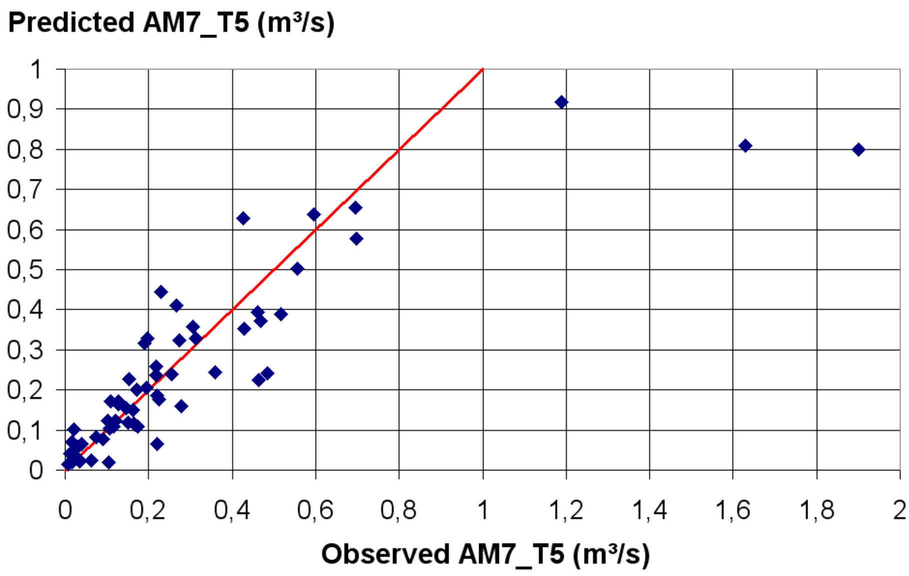

Fig. 1. Scatterplot of predicted vs. observed values of AM7 of the stations used for calibration, for the return period of 5 years