Reply to Interactive comment given by Anonymous Referee no. 1

We would like to thank to Anonymous Referee no. 1 for comments to the paper Methodology for flood frequency estimations in small catchments. Below, the replies to both general and specific particular comments are given. Before the replies to referee comment are given, we would like to introduce our motivation. Main goal of the paper was to present our idea to test the possible improvement of regression based regionalisation techniques by the introduction of shifts in power function which is the most common used for similar purposes. As far as we are aware, this concept (the introduction of shifts) has not yet been published in this research area. Thus, we are focused on the comparison of regional equations derived in usually used way (without shifts) and equations derived with the consideration of shifts. The example of comparison of average slope vs. average CN value is shown on Fig. 1 where the involvement of shifts is justified. It is clear that involvement of shifts leads to much better representation of the data by the fitted curve but we agree that this is paid by lower robustness.

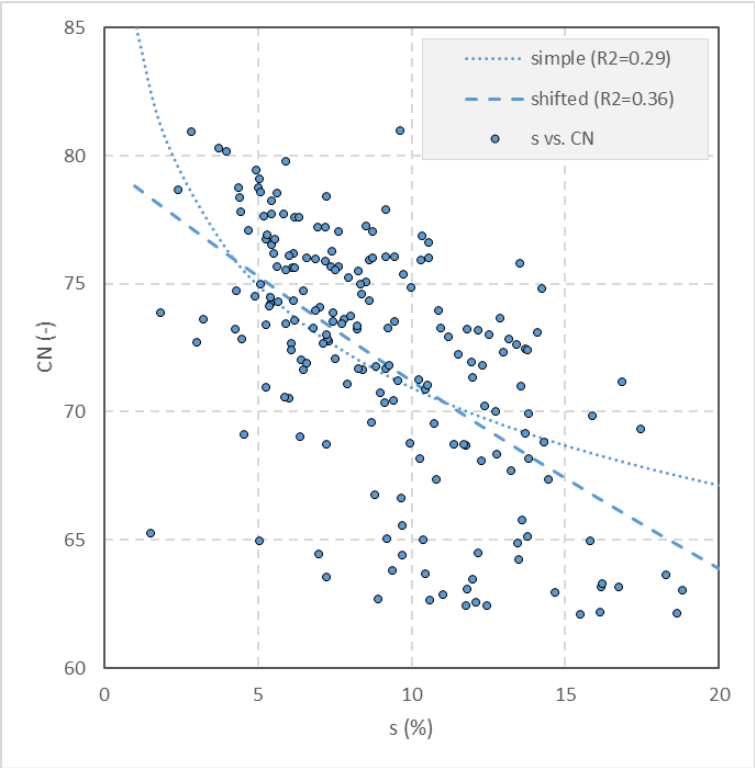

Fig. 1. Comparison of fitted curves for simple power function and the power function with shifts shown on the example of relationship between slope and CN value.

Presented paper consists of two main issues which are the testing of the influence of selected catchment descriptors and the initial estimation of the parameters. The selection of catchment descriptors was done in order to keep as straight influence on flood discharges as possible. Thus, catchment descriptors were avoided which have indirect influence such as mean elevation.

General comments

First of all, we consider as important to give more detail information about parameterisation procedure which is supposed to be necessary for the explanation of some issues raised by the

referee. The parameterisation was carried out by application of two approaches. First, the parameterisation was done step by step from the most important descriptors to the less important ones with fixed values of parameters achieved in previous steps. Second, parameters were estimated all together for each considered combination of descriptors. This was done for both simple power function and the power function with shifts.

The number of parameters involved in the transformation of used descriptors is considered by the referee too high. We agree that the number of model parameters is quite high. The equation in the general form could be simplified and parameters a_i can be avoided by involving them in the general parameter a_0. The methodology has been also parameterised with consideration of a simple power function which means that parameters b_i and d_i representing shifts were fixed to zero. The values of determination coefficient were generally lower than in case of shifted power functions which justifies the involvement of shifts. Moreover, it was considered that the optimised values of b_i and d_i parameters would be equal to zero (and it was in some cases) if there would be no improvement by the shifts. The optimisation procedure was such that the initial values of b_i and d_i were set to zero so their changes were always improving the solution. We agree that the involvement of shifts causes the loss of the robustness.

We think that the comment contained in the second paragraph of general comments results at least partly from inappropriate title of the chapter 4 because this chapter does not contain only the assessment of the importance of the catchment descriptors considered but also the parameterisation of the method. This should be better titled as "Analyses of considered catchment descriptors and model parameterisation". Thus, the chapters 4.1 and 4.2 are related to the analyses of catchment descriptors which were performed in order to sort them according to their importance. The chapter 4.3 focuses then on the parameterisation of the model. Below The answers to the questions arose from this paragraph are:

- Both approaches were applied for the calibration, i.e. with fixed parameters and with re-calibration. The results were better for the second approach which was expected.
- As the least significant descriptor, CN value was identified with respect to both basic analyses as well as further analyses presented in chapters 4.1 and 4.2.

Specific comments

- The method avoids linearization by logarithmic transformation which would be possible in case of simple power function without shifts.
- References to Asquith and Slade (1996) and Olson (2009) are given as an example of catchment descriptors selection and the shape of mathematical model definition. This is not to refer to the method of model parameterization.
- The method used for parameter estimation (Generalized Reduced Gradient - GRG) is referred in the documentation of MS Excel to Lasdon et al. (1976). In general, the procedure of parameter estimation applied for this purpose corresponds to OLS as the R^2 value was maximized (i.e. sum of squares of errors was minimised) with equal weight for each station involved in the data base.
- We agree that the sentence on page 6331 where the black-box approach is mentioned is formulated wrong. We wanted to express that in general the black-box approach is used but

with consideration of catchment characteristics related more or less directly to the estimated value.

- We also agree that scatter plot of predicted vs. observed quantiles would be a good illustration to the outcomes presented in the paper. These are shown on Fig. 2.

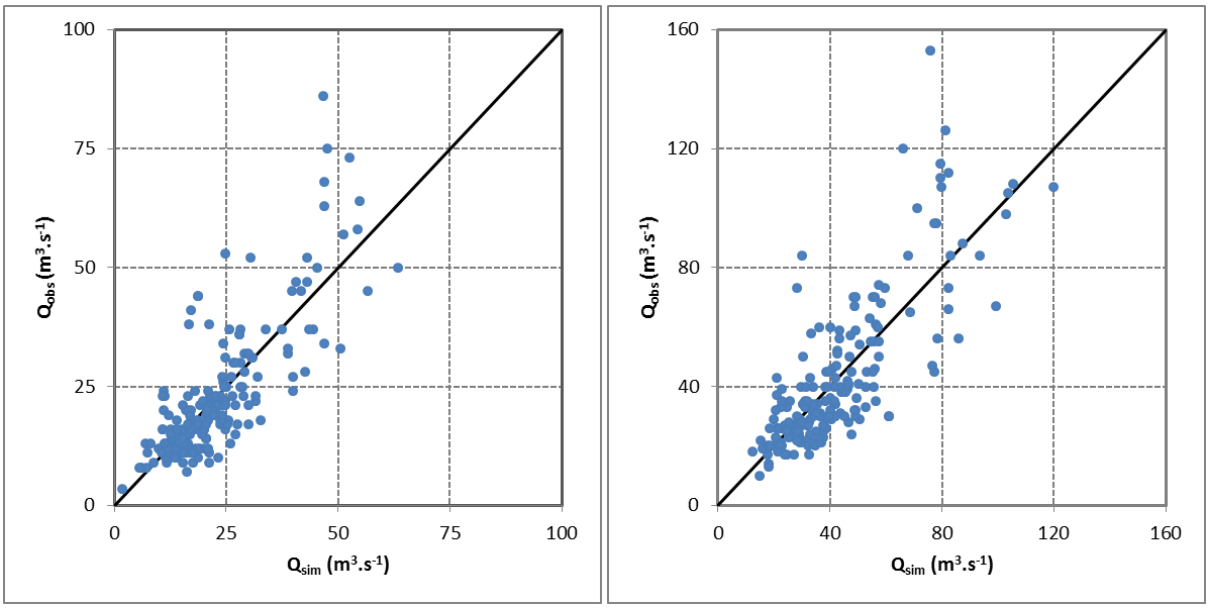

Fig. 2. Scatterplots of estimated vs. observed quantiles for N = 10 yrs (left) and N = 100 yrs (right).

- In the sentence on page 6333, line 9, the word “which” remained after reformulation which had to be deleted.
- The word “accuracy” in line 22, page 6338 was used with respect to the model performance expressed by determination coefficient (R^2).
- We are not sure if we understand the last comment which asks for more support to the results to guide the user to apply the model. We think that the application of the model is simple. It consist only in the application of equations (1) and (2) using estimated values of model parameters together with values of catchment descriptors. The detail shape of the equation is then as follows:

$$Q_{sim} = a_0 \cdot \left[\left(a_1 \cdot (b_1 + A)^{c_1} + d_1\right) \cdot \left(a_2 \cdot (b_2 + P_{24hr})^{c_2} + d_2\right) \cdot \left(a_3 \cdot (b_3 + s)^{c_3} + d_3\right) \cdot \left(a_4 \cdot (b_4 + SF)^{c_4} + d_4\right) \cdot \left(a_5 \cdot (b_5 + CN)^{c_5} + d_5\right) \right] + d_0$$