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Hydrology and Earth System Sciences Discussions

Interactive comment on "Uncertainty in river discharge observations: a quantitative analysis" *by* G. Di Baldassarre and A. Montanari

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We wish to thank Prof. Pegram very much for the helpful review of our manuscript. He raised some important concerns that we found appropriate and very helpful. We would like to provide with this short reply a first comment about how his concerns could be addressed.

The first concern of Prof. Pegram is related to the original contribution provided by the paper. We spent a considerable time revising the literature and got the feeling that only a few authors addressed the problem of estimating the global uncertainty of river discharge measurements retrieved by using the rating curve method. We reported these past studies in the list of references of the paper. Also, we provided additional references in our reply to Referee #2. We have the feeling that the methodology we are proposing to use is original in the use of a numerical flow routing model to investigate

the river flow data uncertainty. Of course we might well be wrong and therefore we would be very delighted to know more additional references (may be through personal communications) that might help us to better put our contribution in the context of the existing literature. We will make any possible effort to update the description of the state of the art if we are allowed to revise the paper.

Prof. Pegram is also concerned by the assumption of independence of the different sources of error originating the global uncertainty of the river flow measurements. Actually, we investigated the dependence of such errors and found that, for a given value of the discharge (and therefore for a fixed time), they look independent. Also, by following a physical reasoning we do not see how the bias of the rating curve could be significantly related to (i) the interpolation error of the rating curve itself, (ii) the uncertainty due to the presence of unsteady flow (that depends on different causes, like the shape of the hydrograph, the celerity of the flood wave and so forth) and (iii) the uncertainty induced by seasonal changes of the rating curve. If dependence existed among these errors, in our opinion it would be not statistically significant. Therefore we found it reasonable to assume that the above errors are independent, by also considering that the assumption is precautionary with respect to uncertainty estimation. The assumption of independence could be easily removed and we would be happy to do so if we were given an explanation for the presence of dependence. If we were allowed to revise the manuscript, we would be willing to better discuss these issues and to present in brief the correlation analysis we did. Indeed, for the sake of conciseness we did not discuss the underlying assumptions in detail and this was a weak point of our manuscript. We also believe that it is reasonable to assume, as we did, that the errors we considered are additive, therefore summing their variance.

We are also willing to better discuss the possible presence of systematic biases that we have excluded from our analysis. Actually, we assumed that the river cross section is not changing in time (for instance, this is the case of a control section) and therefore excluded the presence of this type of bias in the rating curve. Of course, not all

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the errors we considered are purely random. For instance, one may better specify the error due to the presence of non-stationary flow by distinguishing between raising and recessing limb of the hydrograph. In the same way, one may get a better description of the error induced by seasonal variations of the roughness by looking at the season the river flow observation was collected. This type of analysis can be easily included in our methodology and we are willing to do so it if the Editor feels it is advisable. However, we do not think it is helpful to assess the river flow error depending on too many explanatory variables (like the season, the celerity of the flood wave, the river flow regime and so forth). Our aim is to provide the user with an indication of the uncertainty affecting a given observation of the river flow, independently of additional information that could be not readily available (for instance, when dealing with annual peak flow data or occasional river flow observations such additional information is often missing). Nevertheless, we believe the uncertainty assessment we presented is useful. If the user knows the order of magnitude of river flow uncertainty, he can investigate the sensitivity of hydrological models, or flood frequency models, and therefore the sensitivity of, say, an estimated design flow, therefore being able to introduce appropriate safety factors. We would be willing to better discuss the above issues if we were allowed to revise the paper. Also, we are willing to provide a sound justification for using the results of the ISO Rule 748.

The last concern of Prof. Pegram is the most relevant. We fully agree with him that a lumped evaluation of the error over a wide range of river discharges is not very helpful from a practical point of view. To solve this problem we should develop a statistical model relating the uncertainty to the magnitude of the river flow. Such additional work is not an easy task. However, we recognise that this further development is necessary in order to make the paper interesting for HESS. If we were allowed to revise the paper, we would try to develop this additional analysis and we would submit a revised version only if the results are satisfactory.

Once again, we would like to thank Prof. Pegram for the helpful review.

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