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Going back a step - Parameter Uncertainty in Global Hydrology Modelling

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This PhD project aims to investigate the overlooked issue of parametric uncertainties in global hydrological modelling. The effect of climate change on global hydrology has been a popular topic in climate research over the past few decades. Projections of increased temperature and altered rainfall patterns have raised concerns over water security, flood risk, and the occurrence of extreme weather events. Future river discharge studies have previously been at the catchment, or regional scale, and are rarely globally applicable. However, with rapid developments in computational abilities, large scale studies that couple Global Circulation Models with Global Hydrological Models have recently produced global projections of future water availability and flood risk. But how reliable are these estimates? This PhD project has taken the MacPDM.09 Hydrological Model, and subjected it to rigorous testing of its sensitivities to model inputs, and the uncertainties within its outputs. Uncertainty Analysis has been carried out using the Generalised Likelihood Uncertainty Analysis method. The results from this analysis will be taken forward to produce 'uncertainty informed' projections of future global hydrology for 21 major global river basins. This research will lead to more informed future hydrology projections than have been previously available, and will provide methodological guidance for the future testing of other global hydrological models.

This PhD goes back to the very beginning of the uncertainty problem. For any model, be it a climate model or an impacts model, different configurations of the model parameters can produce very different estimates of global futures. In this case, a hydrological model is assessed to investigate the impacts of model calibration on future hydrology projections. Many "model comparison/multi-model" studies have been undertaken in order to address the issue of model uncertainty (e.g. the EU WATCH project), but just one model can be calibrated (set up) in many different ways, and this type of uncertainty has not yet been investigated in this field. Requiring extensive computing power to assess, parametric uncertainties have been largely overlooked in the field of global hydrological science. This project has run 100,000 different hydrological model parameterisations to assess the variance in model output. This type of assessment should ideally be carried out on all models, preferably in the model development stage, and should be documented in the model literature to allow users a full understanding of model uncertainty. Smaller experiments will be done to determine the feasibility of integrating such assessments into the model calibration process, and how many runs are necessary to get an understanding of parameter uncertainty. This work will then go on to investigate the appropriate presentation of uncertainties in this field to the model users, be it averages, ranges or probability distributions.