

Parameter screening: the use of a dummy parameter to identify non-influential parameters in a global sensitivity analysis

Farkhondeh Khorashadi Zadeh (1), Jiri Nossent (1,2), Ann van Griensven (1,3), and Willy Bauwens (1)

(1) Vrije Universiteit Brussel (VUB), Department of Hydrology and Hydraulic Engineering, Pleinlaan 2, 1050 Brussel, Belgium, (2) Flanders Hydraulics Research, Department of Mobility and Public Works, Flemish Government, Antwerp, Belgium, (3) UNESCO-IHE Institute for Water Education, Core of Hydrology and Water Resources, The Netherlands

Parameter estimation is a major concern in hydrological modeling, which may limit the use of complex simulators with a large number of parameters. To support the selection of parameters to include in or exclude from the calibration process, Global Sensitivity Analysis (GSA) is widely applied in modeling practices. Based on the results of GSA, the influential and the non-influential parameters are identified (i.e. parameter screening). Nevertheless, the choice of the screening threshold below which parameters are considered non-influential is a critical issue, which has recently received more attention in GSA literature.

In theory, the sensitivity index of a non-influential parameter has a value of zero. However, since numerical approximations, rather than analytical solutions, are utilized in GSA methods to calculate the sensitivity indices, small but non-zero indices may be obtained for the indices of non-influential parameters. In order to assess the threshold that identifies non-influential parameters in GSA methods, we propose to calculate the sensitivity index of a “dummy parameter”. This dummy parameter has no influence on the model output, but will have a non-zero sensitivity index, representing the error due to the numerical approximation. Hence, the parameters whose indices are above the sensitivity index of the dummy parameter can be classified as influential, whereas the parameters whose indices are below this index are within the range of the numerical error and should be considered as non-influential.

To demonstrate the effectiveness of the proposed “dummy parameter approach”, 26 parameters of a Soil and Water Assessment Tool (SWAT) model are selected to be analyzed and screened, using the variance-based Sobol’ and moment-independent PAWN methods. The sensitivity index of the dummy parameter is calculated from sampled data, without changing the model equations. Moreover, the calculation does not even require additional model evaluations for the Sobol’ method. A formal statistical test validates these parameter screening results. Based on the dummy parameter screening, 11 model parameters are identified as influential. Therefore, it can be denoted that the “dummy parameter approach” can facilitate the parameter screening process and provide guidance for GSA users to define a screening-threshold, with only limited additional resources.

Key words: Parameter screening, Global sensitivity analysis, Dummy parameter, Variance-based method, Moment-independent method