Multi-objective calibration of the physically based, spatially distributed SHETRAN hydrological model

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Abstract

Physically based, spatially distributed hydrological models have mostly been calibrated manually; a few were calibrated automatically but without full consideration of conflicted multi-objectives. Here, we successfully applied the non-dominated sorting genetic algorithm II (NSGA-II) and its two variants, namely the reference point-based R-NSGA-II and the extension ER-NSGA-II, to multi-objective, automatic calibration of the SHETRAN hydrological model. Moreover, we demonstrated the possibility of speeding up the calibration process by adjusting the recombination and mutation parameters of the optimization algorithms. The simulated binary crossover and polynomial mutation were used with respective probabilities of 0.9 and 0.1, and crossover and mutation distribution indices (η_c, η_m) with values of (0.5, 0.5), (2.0, 0.5) and (20., 20.). The results indicate that the use of smaller (η_c, η_m) speeded up the optimization process of SHETRAN calibration, especially during the initial stage, for all three algorithms; however, the use of the R-NSGA-II and ER-NSGA-II did not provide a more efficient optimization compared to the NSGA-II. The broad search of the algorithms, enabled by the generation of diversified solutions due to the use of small (η_c, η_m), contributed to the improved efficiency. Finally, we successfully validated the optimal solutions for both the basin outlet and the internal gauging stations.

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