Efficient Multi Objective Watershed Model Calibration Using a Synchronous Global Surrogate Algorithm

T. Akhtar[1] **and C. A. Shoemaker**[2]

Abstract: Multi-objective optimization (MOO) can identify multiple plausible calibration alternatives and assist decision makers during parameter estimation of complex watershed and hydrological simulation models. However, MOO usually requires many model simulations. This poses a huge challenge in multi-objective calibration of watershed models that are computationally expensive. This paper applies the Multi-Objective Parallel Local Surrogate-Assisted (MOPLS) search algorithm for parallel and efficient global optimization of computationally expensive watershed calibration problems. MOPLS is an iterative parallel surrogate algorithm which incorporates simultaneous local candidate search on response surface models within a synchronous parallel framework to select numerous evaluation points in each iteration. Novelty of MOPLS is embedded in the method for selection of multiple new points for expensive evaluations in each iteration. This selection method incorporates i) efficient Radial Basis Function (RBF) approximation, ii) auto-adaptive neighborhood search, and iii) a Tabu criterion for guiding the search towards promising neighborhoods.

MOPLS is applied for calibration of flow parameters of a SWAT model, (Soil and Water Assessment Tool) designed to simulate flow in the Cannonsville watershed in upstate New York. MOPLS is used with 4, 8, 16, 32 and 64 synchronous parallel processes and results are compared against other efficient MO algorithms including GOMORS, ParEGO, AMALGAM, NSGA-II and MOEA/D. The results indicate that within a limited evaluation budget (2000 function evaluations), MOPLS outperforms other algorithms for computationally expensive watershed calibration problems, when comparison is made both in terms of function evaluations, and also in terms of number of parallel algorithm iterations. Parallel speedup of MOPLS is also impressive, and algorithm efficiency is around 35-40 percent for 64 processors.

[1,2] NUS Environmental Research Institute (NERI),
Department of Industrial Systems Engineering and Management,
Department of Civil and Environmental Engineering, National University of Singapore,
1 Engineering Drive 2, Blk E1A No. 06-25 Singapore 117576
{*erita, shoemaker*}*@nus.edu.sg*