ParaSol (Parameter Solutions) - Ann van Griensven and Tom Meixner

PUB-IAHS Workshop
Uncertainty Analysis in Environmental Modelling
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a) Introduction:

Catchment water quality models have a high number of parameters, several output variables and a complex structure leading to multiple minima in the objective function. General uncertainty/optimization methods based on random sampling (e.g. GLUE) or local methods (e.g. PEST) are often not applicable for theoretical or practical reasons. "ParaSol" (Parameter Solutions) is a method that performs optimization and uncertainty analysis for complex models such as distributed water quality models. Optimization is done by adapting the Shuffled Complex Evolution algorithm (SCE-UA) to account for multi-objective problems and for a large numbers of parameters. The simulations performed by the SCE-UA are further used for uncertainty analysis and allow a focus on solutions near the optimum/optima. Two methods have been developed that select "good" results out of these simulations based on an objective threshold. The first method is based on χ^2-statistics to delineate the confidence regions around the optimum/optima and the second method uses Bayesian statistics to define high probability regions.

b) Advantages

- Deals with multi-objective problems
- Much more efficient than methods that are based on random sampling
- Global sampling

c) Disadvantages

- Only deals with parameter uncertainty due to lack of data of good quality
- Gives parameter ranges, no probability distributions
- Results depend on the underlying success of SCE-UA sampling. The success has only be confirmed for a case with only 2 parameters

d) Assumptions

- Residuals are randomly distributed
- The objective functions are not dependent on each other

e) Most appropriate application areas

Large data-poor complex models with multi-variable outputs (e.g. distributed water quality models)

f) Reading list

van Griensven A. and Meixner T. , 2004. Dealing with unidentifiable sources of uncertainty within environmental models. Proceedings of the International Environmental Modelling and Software Society (iEMSs 2004), 14-17 June 2004 University of Osnabrück, Germany.

g) Software availability

Codes downloadable from website

h) Web links or other information

http://homepages.vub.ac.be/~avgriens/work/uncert.html

i) Figures

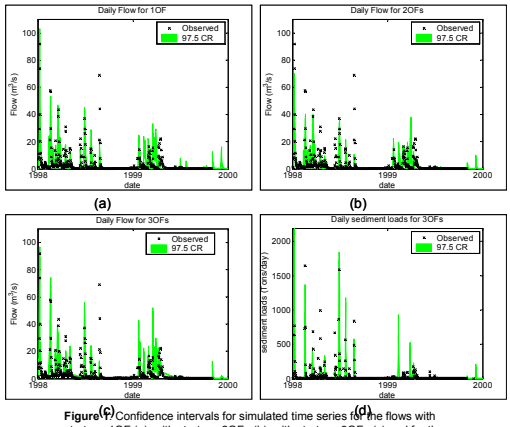

Figure 1: Confidence intervals for simulated time series for the flows with strategy 1OF (a); with strategy 2OFs (b); with strategy 3OFs (c) and for the simulated daily sediment loads with strategy 3OFs (d). The confidence intervals are often small such that they look like a line instead of a bounded area. Note slightly wider uncertainty bounds in panel a as opposed to the other panels of the figure.

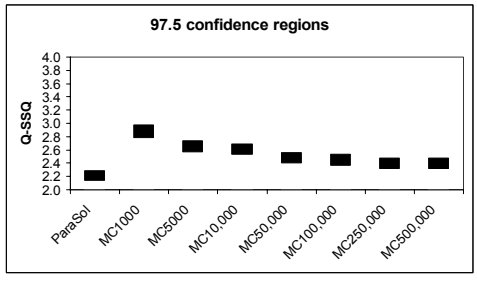

Figure 2: The minimum and maximum value for the Q-SSQ objective function of strategy 1OF in the χ^2 confidence regions according to ParaSol or the Monte-Carlo simulations

j) Delegates Comments (please add !!)