Hydrol. Earth Syst. Sci. Discuss., 12, C1442–C1446, 2015
www.hydrol-earth-syst-sci-discuss.net/12/C1442/2015/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Improving multi-objective reservoir operation optimization with sensitivity-informed problem decomposition" *by* J. G. Chu et al.

J. G. Chu et al.

czhang@dlut.edu.cn

Received and published: 12 May 2015

Title: Improving multi-objective reservoir operation optimization with sensitivity-informed problem decomposition Manuscript ID: hess-2015-92 Authors: J. G. Chu, C. Zhang, G. T. Fu, and H. C. Zhou

Dear Reviewer: We greatly appreciate you for your valuable comments and suggestions. The comments are all valuable and very helpful for revising and improving our paper. The responses to the comments are listed below.

Comment 1: Lines 17-24 on page 3723: Does the red line with circle in Figure 1

represent water supply rule curve for agriculture itself or total water supply of agriculture and industry? If it is for agriculture itself, "The agricultural demand D1 could be fully supplied when the actual water storage is in zone 1, which is above the water supply rule curve for agriculture," - does it mean agriculture has the higher priority than industry water use? However, ". . . the industrial demand D2 has to be rationed when the actual water storage is in zone 3, which is below the water supply rule curve for industry." I think that both D1 and D2 may need to be rationed when the water storage is in zone 2. Do I miss something? Please clarify the explanation for Figure 1.

Response: Thank you for the comments. As we know that water demand could be fully satisfied only when there is sufficient water in reservoir. Water supply operation rule curve, which is used to operate most reservoirs in China, represents the limited storage volume for water supply in each period of the operating year. In detail, water demand will be fully satisfied when the reservoir storage volume is higher than water supply operation rule curve, whereas water demand need to be rationed when the reservoir storage volume is lower than water supply operation rule curve. In general, a reservoir has more than one water supply target, and there is one to one correspondence between water supply rule curve and water supply target. The water supply with lower priority will be limited prior to the water supply with higher priority when the reservoir storage volume is lower. To reflect the phenomenon that different water demands can have different reliability requirements and different levels of priority in practice, the operation rule curve for the water supply with the lower priority is located above the operation rule curve for the water supply with the higher priority. Therefore, in Figure 1, the red line with circle represent water supply rule curve for agriculture, the green line with triangle represent water supply rule curve for industry, and the water supply rule curve for agriculture with lower priority is located above the water supply rule curve for industry with higher priority. Specifically, both the agricultural demand D1 and the industrial demand D2 could be fully supplied when the actual water storage is in zone 1, which is above the water supply rule curve for agriculture; when the actual water storage is in zone 2, which is above the water supply rule curve for industry and below the water supply rule curve for agriculture, the industrial demand D2 could be fully supplied, and the agricultural demand D1 has to be rationed; both the agricultural demand D1 and the industrial demand D2 have to be rationed when the actual water storage is in zone 3, which is below the water supply rule curve for industry. We have clarified the explanation for Figure 1 in the revised paper.

Comment 2: Does the annual value of R in equation (2) equal to W1,j+W2,j?

Response: Thank you for the comments. In Equation (2), R_t is delivery for water use during the period t. Because W_(i,j) (x) is the sum of delivered water for water demand i during the jth year, the sum value of R during the jth year equals to W_(1,j) (x)+W_(2,j) (x) in this paper. We have added the relative description in the revised paper.

Comment 3: Line 10 on page 3727: "need to be translated"

Response: Thank you for the comments. I have corrected the sentence to "The additive ε-indicator measures the smallest distance that a solution set need to be translated to completely dominate the reference set". We have revised the sentence in the revised paper.

Comment 4: Lines 20-22: 39 decision variables for one year? Equation (1) shows there are more than 1 year.

Response: Thank you for the comments. Water supply operation rule curves represent the limited storage volume for water supply in each period of the operating year, which is divided into 24 time periods (with ten days as scheduling horizon from April to September, and a month as scheduling horizon in the remaining months). Decision variables are storage volumes at different time periods on the operation rule curves. For the industrial curve, there are twenty-four decision variables. Because the agricultural water supply occurs only in the periods from the second ten-day of April to the first ten-day of September, there are fifteen decision variables for the agricultural curve. Therefore, there are thirty-nine decision variables in total. Because it could be

assumed that the historical inflow into the reservoir would be repeated in the future, to provide long-term operation guidelines for reservoir management to meet expected water demands in a future planning year, the water demands in the future planning year and long-term historical inflow are used. The optimization objectives for water supply operation rule curves are to minimize water shortages during the long-term historical period. Therefore, Equation (1) computes the water shortages in all historical years. We have added the relative description in the revised paper.

Comment 5: Figure 4: Please explain why those decision variables are most sensitive, intuitively or conceptually. Same for Figure 8.

Response: Thank you for the comments. The most sensitive decision variables could be identified by imposing a user specified threshold (or classification) of sensitivity. The thresholds used to differentiate sensitive and insensitive decision variables are based only on the magnitudes of the sensitivity total-order indices for each decision variable. The thresholds were determined by plotting the magnitudes of the sensitivity total-order indices for each decision. Results were classified as sensitive where the sensitivity total-order index values are larger and changed the most significantly. Insensitive parameters had small sensitivity total-order index values that could not be distinguished. These thresholds are subjective and their ease-of-satisfaction decreases with increasing numbers of parameters or parameter interactions. In all of the results for the Sobol"s method, parameters classified as the most sensitive contribute, on average, at least 10 percent of the overall model variance (Tang et al., 2007a, b). Therefore, in this paper, the most sensitive decision variables are identified based on a total-order Sobol"s index threshold of greater than 10% and 3% in Figure 4 (39 decision variables) and Figure 8 (126 decision variables) respectively. We have added the relative description in the revised paper.

Comment 6: Lines 4-7 on page 3734: "...the Pareto optimal solutions were then used as starting points to start a complete new search..." Since the Pareto optimal solutions from the simplified problem only include the sensitive decision variables, how are the initial values of insensitive variables for the full search determined?

Response: Thank you for the comments. In this paper, the simplified problem is solved with the optimization of sensitive decision variables, the insensitive decision variables are set randomly first and kept constant during the solution of the simplified problem. Therefore, the solutions from the simplified problem, which include optimal sensitive decision variables and the constant insensitive decision variables, are used as staring points to start a complete new search. We have added the relative description in the revised paper.

Comment 7: Lines 6-21 on page 3735: From Figure 10, the authors conclude that the preconditioned full search is more reliable than the regular full search. Did you try different settings for the pre-conditioned full search? E.g., random seeds for obtaining the pre-conditioning search or other parameter settings.

Response: Thank you for the comments. In this paper, we have tried ten random seed trials for obtaining the pre-conditioning search and full search respectively, and we conclude that the preconditioned full search is more reliable than the regular full search based on the comparison of solutions obtained through ten random seed trials.

References Tang, Y., Reed, P. M., van Werkhoven, K., Wagener, T. 2007a. Advancing the identification and evaluation of distributed rainfall-runoff models using global sensitivity analysis. Water Resources Research 43, W06415, doi:10.1029/2006WR005813. Tang, Y., Reed, P. M., Wagener, T., van Werkhoven, K. 2007b. Comparing sensitivity analysis methods to advance lumped watershed model identification and evaluation. Hydrology and Earth System Sciences 11, 793-817.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/12/C1442/2015/hessd-12-C1442-2015-supplement.pdf

---

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 3719, 2015.