Hydrol. Earth Syst. Sci. Discuss., 3, S1940–S1944, 2007
www.hydrol-earth-syst-sci-discuss.net/3/S1940/2007/

Hydrology and Earth System Sciences Discussions

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Interactive Comment

Interactive comment on "Effect of flow forecasting quality on benefits of reservoir operation – a case study for the Geheyan reservoir (China)" *by* X. Dong et al.

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Received and published: 6 February 2007

This could be a potentially interesting paper. However, the proposed methodology has major flaws and some of the research questions must be reformulated.

1). Methodology. The major problem with this paper comes from the fact that the long-term optimization model is deterministic while it is well-known that the monthly reservoir operation problem is stochastic since the inflows are uncertain. A key concept in this is certainty equivalence. If a water system is certainty-equivalent, the optimal operation can easily be found by optimizing the control actions, given the best deterministic forecast, i.e. the expected value of the input. However, the necessary conditions for certainty equivalence require that (Philbrick and Kitanidis, 1999): a) The objective function is quadratic b) System dynamics are linear c) There are no inequality constraints d) Uncertain inputs are normally distributed and independent

In this case, the inequality constraints on min and max storage and min and max release play an important role, making it a non-certainty equivalent problem.

Ignoring this uncertainty will lead to policies that will overestimate the performance of the system making them unsuitable for real-time operation. In addition, the deterministic optimization is carried out with average monthly inflows which do not preserve the temporal persistence (autocorrelation) of the flow generating process. Assessing the value of flow forecasts while ignoring both the uncertainty and the temporal persistence of the flow generating process makes this approach ill-conceived. Hence, we would recommend that the authors derive these policies with the stochastic extension of dynamic programming (SDP). Another option, is to use the approach developed by Faber and Stedinger (2001) and to combine Sampling SDP with ensemble streamflow prediction (ESP). Then the entire future value function can be used to derive daily operating policies from a short-term optimization model. This coupling is more realistic than the proposed approach based on target storage volumes as it fully exploits the information of the future value function. In addition, it provides more flexibility in allocating water in time since the process is no longer driven by a physical criteria (the target volume) but by an economic criteria: the comparison between the immediate and future marginal water values in the reservoir.

In brief: -Use an appropriate (stochastic) optimization algorithm to derive long-term operating policies -Use stochastic (ensemble) forecasts and past historical flows for both the long and short-term operations -Make sure that the forecast accuracy decreases as the forecast horizon increases.

2) Research questions. The authors have identified three research questions (page

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377).

2-1. Coupling the short-term (ST) model with the long-term (LT) model. As mentioned above, the traditional approach based on target storage volumes could easily be replaced by an approach based on the future value function. The basic principle is similar: the terminal value function of the short-term optimization model is the future value function obtained from the LT model. Since the authors are using DP (or preferably SDP) to derive monthly reservoir operating policies, the future value functions are the results of the optimization model (together with the release policies) and can be used as a “boundary condition” to determine ST operating policies.

2-2. Limit to the extension of the lead time. It will depend pretty much on the extent to which the reservoir can store water (flexibility, i.e. the ability to move water in time). LT forecasts are important for seasonal and multiyear reservoirs. They are irrelevant for run-of-river power plants. ST forecasts are less important for “big” reservoirs. They are crucial for run-of-river power plants.

2-3. Value of flow forecasts. See point 2-2. From information theory we know that better forecasts should lead to higher benefits because of the reduced uncertainty. We also know that including longer forecasts will not decrease the performance of the system but might increase the cost of forecasting. Analyzing the costs and benefits of better forecasting techniques is therefore important but it is also highly specific to the case-study.

3) Miscellaneous.

-Top of page 3780: Is the input data to the long term model the monthly multiyear average or the monthly 1997 average?

-There are no losses in eq. 9 (evaporation, spillage)?

-There is no terminal value function in eq. 7, meaning that the reservoir is depleted at the end of the planning period since the immediate benefit function stresses energy

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maximization! On Fig 4 we can see that the storage level at the beginning of month #12 is almost 75% and then the comes close to 0% at the end of the month. So, in less than one month, the reservoir is suddenly depleted while the storage levels in the previous months were slightly decreasing. In addition, the reservoir is not empty at the beginning of the year while it should be empty at the end of the previous yearĚ

-There is no need to describe the discrete DP backward recursion as it is well known (page 3790+Fig 6).

-From p. 3785 we can understand that the number of discrete storage volumes is 500 (40m/0.08m). This means that the number of trajectories for a given stage and can be as many as 250,000, which is quite large! One could use a coarser grid and interpolate between the points instead of relying only on the predefined trajectories.

-The threshold lead time of 33 days is only valid for this specific year and cannot be generalized

-7.3 : operation should be based on the maximization of benefits, making optimal use of the information contained in the forecasts. If the maximization of power is the objective and the optimization scheme is correct, the forecast accuracy would be the only factor improving the performance of the system.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 3, 3771, 2006.