Using SDDP to Perform Basin-Wide Water Resources Assessments with Limited Data Availability

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Using SDDP to Perform Basin-Wide Water Resources Assessments with Limited Data Availability

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Abstract: In many situations, water resources assessments are hindered by the limited availability of data concerning both water supplies and demands. Stochastic dual dynamic programming (SDDP) is one of few solutions available to determine optimal allocation policies in large-scale water resources systems. Yet, limited data on water demands and hydraulic infrastructure leads to the existence of multiple near-optimal solutions (MNOS). This work shows that when MNOS exists, SDDP is very sensitive to even minimal variations of the problem setting, e.g. initial conditions – we call this “algorithmic chaos”. Besides, the approximations of the benefit-to-go function that SDDP constructs at each stage using a set of hyperplanes (cuts), can lead to different decisions in distinct simulation years even for the same point in the state-space. Results that exhibit such sensitivity are difficult to interpret. This work proposes a year-periodic re-optimization method, which simulates system decisions by periodically applying cuts from one given year from the SDDP run. Simulation results obtained through this re-optimization approach are steady-state solutions, meaning that their probability distributions are stable from year to year. A case-study of the transboundary Zambezi River basin in Southern Africa illustrates both the issues associated with limited data availability when using SDDP, and how the proposed re-optimization method solves them.

Keywords: Limited data availability; Large-scale water resources systems; Stochastic dual dynamic programming; Multiple near-optimal solutions; Zambezi River basin.