PENGEMBANGAN KONSEP POLA OPERASI WADUK DAN EVALUASI PENERAPANNYA DENGAN SIMULASI MONTE CARLO
(Studi Kasus: Sistem Terintegrasi Bendung Gerak Segawe, Bendungan Serbaguna Wonorejo, dan Bendung Gerak Tiudan, Kabupaten Tulungagung)

INTISARI

Pola Operasi Waduk (POW) telah dikenal sebagai suatu acuan operasi waduk yang tersusun dari tiga pasangan aturan rilis dan *rule curve* pada kondisi kering, normal, dan basah menurut *inflow* andalan tertentu. Namun, penerapan POW beserta pengaruhnya dalam pemenuhan kebutuhan air masihlah tidak jelas. Tesis ini membahas suatu pengembangan konsep POW dan mengevaluasi kinerja penerapannya dalam sistem terintegrasi Bendung Gerak Segawe, Bendungan Serbaguna Wonorejo, dan Bendung Gerak Tiudan. Dalam sistem tersebut, Bendung Segawe tidak memiliki tampungan dan perlu melayani Daerah Irigasi (DI) Blader-Kluwih-Gelang sekaligus menyuplai air secara paralel ke Waduk Wonorejo. Sementara itu, Bendungan Serbaguna Wonorejo perlu merilis tampungannya untuk pembangkitan listrik dan konservasi tampungan harian Bendung Gerak Tiudan yang melayani DI Paingan dan suplai air baku. POW Wonorejo yang mengintegrasikan aturan rilis pada ketiga bangunan air disusun melalui optimasi alokasi air pada 36 periode dalam setahun. Kinerja POW Wonorejo dievaluasi berdasarkan kejadian dalam simulasi Monte Carlo dengan *inflow* sintetik yang dibangkitkan melalui model Thomas-Fiering. Keputusan rilis pada ketiga bangunan air pada setiap langkah waktu simulasi ditentukan sebagai aturan rilis menurut posisi muka air aktual Waduk Wonorejo terhadap *rule curves* POW, di mana Waduk Wonorejo ditetapkan penuh pada awal simulasi. POW Wonorejo disimulasikan dengan dua alternatif, yakni POW-D65 dan POW-D80 yang secara berurutan tersusun dengan keandalan *inflow* kering sebesar 65% dan 80%. Berdasarkan hasil 1.000 simulasi, *reliability* terendah untuk pemenuhan 70% kebutuhan DI Blader-Kluwih-Gelang, 70% kebutuhan DI Paingan, dan 85% kebutuhan suplai air baku menurut POW-D65 secara berurutan adalah 69,5%, 100%, dan 73,9%, sedangkan menurut POW-D80 secara berurutan adalah 69,5%, 99,8%, dan 52,4%. Kedua POW secara berurutan dapat menghasilkan energi listrik setidaknya setinggi 480,15 dan 457,92 MWh dengan keandalan 85%. Frekuensi Waduk Wonorejo penuh kembali pada akhir simulasi menurut kedua POW secara berutuan adalah 76,4% dan 81,3%.

Kata kunci: Alokasi Air Terintegrasi, Kinerja Operasi Waduk, Model Thomas-Fiering, Penerapan Pola Operasi Waduk, Simulasi Monte Carlo

CONCEPT DEVELOPMENT OF RESERVOIR OPERATING PATTERN AND EVALUATION ON ITS APPLICATION IN MONTE CARLO SIMULATION

(Case Study: Integrated System of Segawe Regulating Weir, Wonorejo Multipurpose Dam, and Tiudan Regulating Dam, Tulungagung Regency)

ABSTRACT

Reservoir Operating Pattern (ROP) has been well-known in Indonesia as a reference for reservoir operation which comprises three sets of release rule and rule curve in dry, normal, and wet conditions based on certain dependable inflows. However, the application of ROP and its influence in satisfaction of water demands have remained unclear. This thesis discusses a concept development of ROP and evaluates the performance from its application in the integrated system of Segawe Regulating Weir, Wonorejo Multipurpose Dam, and Tiudan Regulating Dam. In this integrated system, Segawe Regulating Weir is incapable of storing water and must irrigate the Blader-Kluwih-Gelang paddy field (PF Blader-Kluwih-Gelang) while supplying water in a parallel scheme to Wonorejo Reservoir. Meanwhile, Wonorejo Multipurpose Dam must release its storage to generate electricity as well as to conserve the daily storage of Tiudan Regulating Dam that serves for the PF Paingan irrigation and domestic water supply. Wonorejo ROP which integrates the release rules in three river structure was derived from optimization of water allocation on 36 periods in one year. Performance of the Wonorejo ROP was evaluated according to the events in Monte Carlo simulation with synthetic inflow time series generated from the Thomas-Fiering model. The release decision in each river structure on every simulation time step was determined as a release rule in accordance with the actual water level of Wonorejo Reservoir to the rule curves of ROP, where Wonorejo Reservoir was conditioned to be full at the start of simulations. Wonorejo ROP was evaluated with two alternatives, namely ROP-D65 and ROP-D80 which were derived with the dry inflow dependencies of 65% and 80%, respectively. Based on 1,000-simulation results, the lowest reliabilities in satisfaction of 70% of the demands for the PF Blader-Kluwih-Gelang irrigation, 70% of the demands for the PF Paingan irrigation, and 85% of the demands for domestic water supply according to ROP-D65 were 69.5%, 100%, and 73.9%, respectively, while according to ROP-D80 were 69.5%, 99.8%, and 52.4%, respectively. The two alternatives of ROP resulted in the lowest electrical energies of 480.15 and 457.92 MWh, respectively, at 85% dependency. The frequencies for Wonorejo Reservoir to be back in full condition at the end of simulations according to the two alternatives of ROP were 76.4% and 81.3%, respectively.

***Keywords**: Application of Reservoir Operating Pattern, Integrated Water Allocation, Monte Carlo Simulation, Performance of Reservoir Operation, Thomas-Fiering Model*