UNIVERSITI PUTRA MALAYSIA

SIMULATED OPTIMIZATION OF RESERVOIR OPERATIONS OF THE ZAYANDEHRUD DAM, IRAN

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By

MINA ZIAEI

August 2010

This work is dedicated to my Mother Mrs. I. Amigh, and my Father Mr. L. Ziaei

Abstract of thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman: Professor Lee Teang Shui, PhD

Faculty: Engineering

Due to severe droughts in the Isfahan province of Iran and limited water resources (arid and semi-arid climate), managing optimum operation of these resources is important. The two parts of this study are the use of HEC-ResSim to carry out a simulation phase and the optimal operation phase by using LINGO model for single-objective optimization. The objective function of the optimization model is maximizing the total release for various demands downstream of the dam. The operation of the reservoir-river system should be based on practical guidelines for the storage or release of water to meet the project demands. The rule curve and optimal operation policies of the Zayandehrud dam can be explained by average regulatory output of the dam per month during the period covered (1957-2003).

Another important step in the optimization model is evaluation of reservoir operation policy performance. Evaluation indexes are very applicable to achieve this goal. One of the most important index is the reliability index. The reliability index was considered to compare the dam operation based on the prepared policies (rule curve) with standard operation policies (SOP) and downstream demands. Results indicate that the optimized operation of the Zayandehrud dam will increase the storage of reservoir by 88.9%, increase the times when the reservoir is full by 5.2% and reduce the times when the reservoir is empty by 18.6%. Although, the optimization of the Zayandehrud reservoir operation resulted in a 3.1% reduction of the total supply, it has however realized a 10.8% increase in the reliability index of regulatory water for all the requirements. The result of the simulation analysis shows that the volume of reservoir storage during the 47-yr period is 636.1 and 336.8 million cubic meters during optimization and standard operation (non-optimization), respectively. Results indicate that under optimal conditions 33 months (5.9%) and that under standard operating conditions (non-optimal) only 4 months (0.7%) the reservoir would be filled over the period. Also during optimal conditions 76 months (13.5%) and non-optimal conditions 181 months (32.1%) respectively the reservoir would be empty over the period. The results reveal an increase of 88.9% of reservoir storage volume under optimized operation condition.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi Keperluan untuk ijazah Master Sains

PENGOPTIMUMAN TERSELAKU OPERASI TAKUNGAN UNTUK EMPANGAN ZAYANDEHRUD DI IRAN

Oleh

MINA ZIAEI

Ogos 2010

Pengerusi: Prof Lee Teang Shui, PhD

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Akibat kemarau di Daerah Isfahan, Iran serta sumber air yang terhad (iklim gersang dan separa-gersang), pengurusan sumber sumber ini secara kadar beroperasi optimum adalah penting. Kajian kedua bahagian ini merangkumi pengunaan HEC-ResSim untuk fasa simulasi dan penggunaan model LINGO untuk pengoptimum objektif-tunggal bagi fasa operasi optimum. Fungsi obkjetif model pengoptimum ialah memaksimumkan jumlah keluaran aliran demi menyelesaikan permintaan dihilir empangan. Operasi sistem empangan-sungai berdasarkan kepada peraturan praktik untuk simpanan atau keluaran air semoga memenuhi keperluan projek. Lengkung aturan dan polisi operasi optimum empangan Zayandehrud boleh diterangkan berdasarkan keluaran peraturan purata empangan bulanan dalam jangkamasa kajian (1957-2003). Satu langkah penting di dalam model pengoptimuman ialah penilaian prestasi polisi operasi empangan. Indeks penilaian sesuai diguna untuk mencapai matlamat tersebut. Satu indeks terpenting ialah indeks kebolehharapan. Indeks ini diguna untuk membandingkan operasi empangan berdasarkan

polisi tersedia (lengkung aturan) dengan polisi operasi piawai (SOP) dan permintaan di hilir. Keputusan menjelaskan bahawa dengan operasi optimum empangan Zayandehrud akan neningkatkan simpanan sebanyak 88.9%, memanjangkan jangkamasa empangan penuh sebanyak 5.2% dan mengurangkan jangkamasa empangan kosong sebanyak 18.6%. Walaupun pengoptimuman operasi empangan Zayandehrud mengurangkan 3.1% jumlah bekalan, akan tetapi indeks kebolehharapan air peraturan untuk semua keperluan neningkat 10.8%. Keputusan analisis simulasi menunjukkan bahawa isipadu simpanan empangan pada jangkamasa 47 tahun ialah 636.1 dan 336.8 juta isipadu meter pada masa operasi optimum dan operasi piawai, masing masing. Hasil kajian menunjukkan bahawa dalam keadaan optimum 33 bulan (5.9%) dan dalam keadaan operasi piawai (tak-optimum) hanya 4 bulan (0.7%), empangan diisi-penuh dalam jangkamasa tersebut. Pada keadaan optimum 76 bulan (13.5%) dan keadaan tak-optimum 181 bulan (32.1%) masing masing, empangan adalah kosong dalam jangkamasa berkenaan. Hasil kajian juga menunjukkan kenaikan 88.9% isipadu simpanan empangan dalam keadaan operasi optimum.

I certify that an Examination Committee has met on **30th of August** to conduct the final examination of **Mina Ziaei** on her degree thesis entitled "**Simulated optimization of reservoir operations of the Zayandehrud dam, Iran**" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the (Master degree).

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.

Mina Ziaei

Date: **30 August 2010**

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