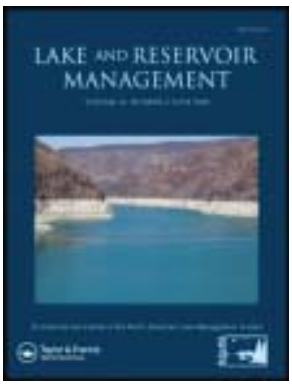

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Simulating hedging rules for effective reservoir operation by using system dynamics: a case study of Dez Reservoir, Iran

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Simulating hedging rules for effective reservoir operation by using system dynamics: a case study of Dez Reservoir, Iran

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Abstract

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Some of the most important challenges facing water managers are to increase water supply and reduce its demand. A single systematic method is needed to address both issues, such as the System Dynamics (SD) modeling approach. In this approach all the factors, parameters, and their influences on the problem are considered by causal loops and stock-flow diagrams. The multipurpose Dez Reservoir in southwestern Iran is a good case study for this approach, and we simulated 10 years under differing operation strategies to develop the most appropriate operation policy. A hydrologic time series analysis was conducted to generate simulated inflow to the reservoir, and differing policies, including hedging rules and a "goal-seeking hedge," were applied. By using performance criteria and a new measure entitled "corrected reliability,", the most appropriate scenarios were identified. We found that using the goal-seeking hedge in combination with water demand management offers the best chance for effectively meeting demands and minimizing supply shortages.

Key words: performance criteria, reservoir operation, time series analysis

High population growth combined with limited water resources has led to water shortages that present a serious challenge for many countries. As a result, many are developing management policies to address the problem. Loucks et al. (2005) and Mays and Tung (2002) provided an appropriate basis for traditional approaches to water resources planning. Wurbs et al. (1985) presented a review paper listing more than 700 references as a bibliography on techniques of reservoir operation. Yeh (1985) also conducted an appropriate review on different reservoir simulation and optimization approaches and noted that, despite improvements presented in the literature, a practical method for reservoir analysis has not yet been achieved, in part because operators are excluded from the policy-making process and partly because simplified computer programs and operation policies are not suitable for complicated, actual cases. Nonetheless, since 1985 there has been much work done in reservoir analysis using different practical methodologies.

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One efficient tool in reservoir operation modeling that is attracting attention from water resources researchers is System Dynamics (SD), a simulation technique based on feedback of system elements. Keyes and Palmer (1993) developed an SD model for drought studies, and following that, Matthias and Frederick (1994) used SD modeling to study sea level variation in coastal regions. Along with these studies, Simonovic et al. (1997) and Simonovic and Fahmy (1999) used SD approach for long-term planning of water resources and policy analysis of the Nile River basin.

In recent years, use of SD as an effective simulation approach in various studies on water resources management has accelerated. Zhang et al. (2008) developed a complex SD model to integrate Tianjin, China, water resources management and then presented reasonable predictive results for policy-making on water resource allocation and management. Fagan et al. (2010) developed a dynamic system-modeling framework to provide a comprehensive set of dynamic performance metrics, integrating all subsystems of the water cycle. In Iran, Bagheri et al. (2010) adopted an SD modeling approach to examine the impacts of various