Investigation of Reservoir Qualitative Behavior Resulting from Sudden Entry of Biological Pollutant

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Abstract: In this paper, fluctuation in reservoir water quality is simulated and evaluated upon the sudden entry of a biological load. By using Version 3.2 of the two-dimensional quality simulation software CE-QUAL-W2, Iran's Karaj Reservoir is simulated, and a biological pollutant with coliform index is considered as the level of the pollutant. By considering factors involved in dispersion, advection, and decay of coliform, nine factors (nine sets of scenarios) are defined, and their influences on the pollution behavior are investigated. To investigate further, pollutant behavior is evaluated in various scenarios: water release, level of water withdrawals, input pollutant load volume, coliform decay rate, stored water volume in the reservoir, entry location of pollutant load, effect of water temperature on coliform decay, inflow to reservoir, and coliform sedimentation rate. Results show that some factors affect the pollutant behavior significantly, such as stored water volume in the reservoir and entry location of the pollutant load, so that the main changes in released pollution concentration appear with a decrease and increase of 25% in reservoir storage volume. Also, the closer the pollutant load entry location to the reservoir outlet, the higher the released pollution concentration. Maximum pollution released from the reservoir in the condition of entry of pollutant load in the lower third of the reservoir relative to the entry of pollutant load in the upper third is 15 times more. **DOI:** 10.1061/(ASCE)IR.1943-4774.0000865.

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Introduction

Often drinking water needs are supplied by surface water sources. Entry of pollutants into these resources can increase health risks. Even from a security perspective and passive defense, water resources and facilities of water withdrawal, transport, treatment, and distribution are very important. Those water resource centers can be considered as the main political and economic centers of each country and thus ensure sustainable socioeconomic development at national and international levels. Preparation of a management system based on a monitoring system, continuous quality evaluation, use of mathematical models for qualitative simulation as well as suggestion of appropriate management scenarios, can guarantee an environmental quality control.

Recently, many optimization techniques have been developed and applied in all aspects of water resource systems, such as reservoir operation (Bozorg Haddad et al. 2011a; Fallah-Mehdipour et al. 2011a, b, 2012a, 2013a; Ashofteh et al. 2013, 2014), hydrology (Orouji et al. 2013), project management (Bozorg Haddad et al. 2010b; Fallah-Mehdipour et al. 2012b), cultivation rules (Bozorg Haddad et al. 2009; Noory et al. 2012; Fallah-Mehdipour et al. 2013b), pumping schedules (Bozorg Haddad et al. 2011b), hydraulic structures (Bozorg Haddad et al. 2010a), water distribution networks (Bozorg Haddad et al. 2008; Fallah-Mehdipour et al. 2011a; Seifollahi-Aghmiuni et al. 2011, 2013), optimal design and operation of pumped-storage and hydropower systems (Bozorg Haddad et al. 2014), operation of aquifer systems (Bozorg Haddad and Mariño 2011), site selection of infrastructures (Karimi-Hosseini et al. 2011), and algorithmic developments (Shokri et al. 2013). Only a few of these works dealt with the investigation of reservoir qualitative behavior resulting from the sudden entry of a biological pollutant into a reservoir system.

Minimization of damages resulting from detection of sudden pollutants is significant for crisis management of the infrastructure of each country. Modeling river–reservoir system quality and forecasting system behavior under a pollutant sudden entry can be useful for analysis of system reactions.

Many studies have addressed reservoir water quality. In this regard, Orlob and Selena (1970) presented a one-dimensional mathematical model to simulate the thermal behavior of deep lakes. In their study, the energy transfer process in the water layer depth was modeled in the Fontana reservoir with four processes: convection transfer, direct sunlight, transfer of surface cooling, and effective diffusivity. Results showed that the performance of the proposed model was successful for different climatic conditions.

Loftis et al. (1985) linked a one-dimensional thermal stratification model for the Vestax reservoir with an optimization model, called operation system dynamic program (OSDP), in which supply of qualitative needs was considered separately. At each daily time step, the squared deviation from the target temperature was computed, and releases from different levels were determined, so that a desirable temperature difference is achieved. Results

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