ESTIMASI LAJU SEDIMENTASI DAN PREDIKSI UMUR LAYANAN WADUK BENER JAWA TENGAH MENGGUNAKAN MODEL SWAT

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INTISARI

Waduk Bener di Provinsi Jawa Tengah merupakan bagian dari daerah aliran sungai (DAS) Bogowonto yang termasuk dalam DAS prioritas karena terjadi perubahan penggunaan lahan secara signifikan. Perubahan penggunaan lahan dapat mendorong peningkatan laju sedimentasi sehingga berdampak pada umur waduk. Waduk Bener sebagai waduk serbaguna yang termasuk dalam Proyek Strategis Nasional dan mendukung ketahanan pangan menjadi alasan dilakukan penelitian ini. Penelitian ini bertujuan menganalisis kerawanan erosi di DTA, mengestimasi laju sedimentasi, dan memperkirakan umur layanan Waduk Bener.

Laju sedimentasi Waduk Bener didapatkan dari estimasi pemodelan *Soil and Water Assessment Tool* (SWAT) dengan efisiensi tangkapan sedimen metode Brune modifikasi. Unit respons hidrologi pada model SWAT didasarkan pada kesamaan topografi, tanah, dan penggunaan lahan. Model SWAT dijalankan berdasarkan data cuaca observasi waktu 2011–2022. Hasil model SWAT dilakukan kalibrasi dan validasi berdasarkan data debit dan muatan sedimen observasi. Model diterima dan dapat dianalisis apabila NSE > 0,5; R^2 > 0,5; dan PBIAS < 25%. Umur layanan waduk diperoleh dari perubahan lengkung kapasitas waduk dari perhitungan distribusi sedimen dengan metode pengurangan luas. Perhitungan umur layanan waduk didasarkan pada dua pendekatan ketika elevasi *intake* tertutup oleh endapan sedimen dan ketika tampungan mati sudah penuh dengan sedimen.

Statistik kinerja model SWAT saat validasi debit memiliki nilai NSE = 0,889; R^2 = 0,890; dan PBIAS = 0,86% sedangkan saat validasi muatan sedimen memiliki nilai NSE = 0,582; R^2 = 0,730; dan PBIAS = 11,67%. Rata-rata laju erosi di DTA Waduk Bener hasil model SWAT adalah 176,9 ton/hektare/tahun. Besarnya rata-rata laju sedimentasi Waduk Bener sebesar 574.611 ton/tahun atau setara dengan volume sedimen 499.662 m^3/tahun. Umur layanan Waduk Bener berdasarkan tertutupnya elevasi *intake* diperkirakan berakhir 29,32 tahun setelah waduk beroperasi. Apabila didasarkan pada penuhnya tampungan mati oleh sedimen, umur layanan Waduk Bener berakhir tepat 51 tahun setelah waduk beroperasi.

Kata kunci: laju sedimentasi, pemodelan hidrologi, SWAT, umur layanan, Waduk Bener

SEDIMENTATION RATE ESTIMATION AND SERVICE LIFE PREDICTION OF BENER RESERVOIR IN CENTRAL JAVA USING SWAT MODEL

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ABSTRACT

Bener Reservoir in Central Java Province is part of the Bogowonto watershed, which is a priority watershed due to significant land use change. Land use change can lead to an increase in sedimentation rates and thus impact the life of the reservoir. Bener Reservoir as a multipurpose reservoir that is included in the National Strategic Project and supports food security is the reason for this research. This study aims to analyze erosion proneness in the catchment area, estimate sedimentation rates, and estimate the service life of the Bener Reservoir.

The sedimentation rate of Bener Reservoir is obtained from Soil and Water Assessment Tool (SWAT) modeling estimation with modified Brune method trap efficiency. Hydrological response units in SWAT model are based on similarities in topography, soil, and land use. The SWAT model is run based on observed weather data for 2011-2022. SWAT model results are calibrated and validated based on observed discharge and sediment load data. The model is accepted and can be analyzed if NSE > 0.5; R2 > 0.5; and PBIAS < 25%. The service life of the reservoir is obtained from the change in the reservoir capacity curve from the sediment distribution calculation by the area reduction method. Reservoir service life calculations are based on two approaches when the intake elevation is covered by sediment deposits and when the dead storage is full of sediment.

SWAT model performance statistics when validating discharge has a value of NSE = 0.889; R^2 = 0.890; and PBIAS = 0.86% while when validating sediment load has a value of NSE = 0.582; R^2 = 0.730; and PBIAS = 11.67%. The average erosion rate in the Bener Reservoir catchment area from the SWAT model is 176.9 tons/hectare/year. The average sedimentation rate of Bener Reservoir is 574,611 tons/year or equivalent to a sediment volume of 499,662 m^3/year. The service life of Bener Reservoir based on the closed intake elevation is estimated to end 29.32 years after the reservoir is operational. If based on the full dead storage by sediment, the service life of Bener Reservoir ends exactly 51 years after the reservoir is operational.

Keywords: *Bener Reservoir, hydrological modelling, sedimentation rate, SWAT, service life*