

ANALISIS EFEKTIVITAS WADUK HALIM TERHADAP PENGENDALIAN BANJIR PADA SEGMENT KALI SUNTER DI KAWASAN LANUD HALIM PERDANAKUSUMA MENGGUNAKAN PEMODELAN HEC-RAS 2D BERBASIS DTM LIDAR

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INTISARI

Kawasan Halim Perdanakusuma, Jakarta Timur, kerap mengalami banjir akibat luapan Kali Sunter, sementara kinerja Waduk Halim sebagai bangunan pengendali banjir belum pernah dievaluasi secara kuantitatif. Penelitian ini bertujuan menganalisis efektivitas Waduk Halim dalam mengurangi banjir pada segmen Kali Sunter menggunakan pemodelan hidrologi-hidraulika berbasis HEC-HMS dan HEC-RAS 2D dengan Digital Terrain Model (DTM) LiDAR, sehingga perubahan karakteristik aliran dan genangan dapat dianalisis secara spasial. Analisis hidrologi dilakukan menggunakan HEC-HMS 4.13 dengan hujan rancangan kala ulang 25 tahun yang diperoleh melalui distribusi Log Pearson Tipe III serta ditransformasikan menggunakan metode SCS Curve Number dan SCS Unit Hydrograph. Hidrograf hasil simulasi digunakan sebagai kondisi batas pada model HEC-RAS 6.6 aliran tak tunak dua dimensi untuk mensimulasikan kondisi sebelum dan sesudah keberadaan Waduk Halim pada skenario debit banjir rencana Q25 dan kejadian banjir ekstrem 1 Januari 2020. Penggunaan HEC-RAS 2D dipilih karena mampu merepresentasikan dinamika aliran pada saluran sungai dan floodplain secara dua dimensi, sedangkan DTM LiDAR digunakan sebagai terrain model berketelitian tinggi untuk merepresentasikan morfologi permukaan tanah, jalur aliran, cekungan topografi, serta batas genangan secara lebih realistis. Model divalidasi menggunakan data tinggi muka air, debit observasi dari pos duga air BBWS Ciliwung Cisadane, serta bukti genangan lapangan.

Hasil penelitian menunjukkan bahwa pada skenario Q25, Waduk Halim menurunkan debit puncak hilir dari 102,97 menjadi 85,66 $m^3/detik$ (16,8%) serta mengurangi luas genangan dari 31,98 menjadi 24,94 *ha* (22,0%). Sebaliknya, pada kejadian banjir ekstrem 1 Januari 2020, reduksi debit puncak dan luas genangan masing-masing hanya sebesar 2,3% dan 1,0%. Berdasarkan indikator penurunan debit puncak dan luas genangan yang digunakan dalam penelitian ini, Waduk Halim menunjukkan kinerja yang baik pada skenario banjir rencana Q25, namun kontribusinya menjadi sangat terbatas pada kejadian banjir ekstrem ketika volume banjir melampaui kapasitas tampungan waduk. Penelitian ini menunjukkan bahwa integrasi HEC-RAS 2D berbasis DTM LiDAR mampu memberikan representasi spasial yang lebih rinci terhadap dinamika aliran dan genangan, sehingga dapat mendukung evaluasi kinerja infrastruktur pengendali banjir secara lebih komprehensif dan menjadi dasar dalam perencanaan mitigasi banjir di kawasan perkotaan.

Kata Kunci: Waduk Halim, Kali Sunter, HEC-RAS 2D, DTM LiDAR, pengendalian banjir.

EVALUATING THE FLOOD MITIGATION PERFORMANCE OF HALIM RESERVOIR ALONG THE KALI SUNTER REACH USING LIDAR-DERIVED DIGITAL TERRAIN MODELS AND HEC-RAS 2D MODELING

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ABSTRACT

The Halim Perdanakusuma area in East Jakarta frequently experiences flooding due to the overflow of the Sunter River, while the hydraulic performance of Halim Reservoir as a flood control structure has not yet been quantitatively evaluated. This study aims to assess the effectiveness of Halim Reservoir in mitigating floods along the Sunter River using an integrated hydrological–hydraulic modelling approach based on HEC-HMS and HEC-RAS 2D with a LiDAR-derived Digital Terrain Model (DTM), enabling the spatial analysis of flow characteristics and flood inundation.

Hydrological analysis was conducted using HEC-HMS 4.13 with a 25-year design rainfall estimated by the Log Pearson Type III distribution and transformed using the SCS Curve Number and SCS Unit Hydrograph methods. The simulated flood hydrograph was used as the upstream boundary condition in an unsteady two-dimensional HEC-RAS 6.6 model to simulate hydraulic conditions before and after the construction of Halim Reservoir under both the Q25 design flood and the extreme flood event of 1 January 2020. The HEC-RAS 2D model was employed because it is capable of explicitly representing the spatial dynamics of flood flows within the river channel and adjacent floodplain, while the LiDAR-derived DTM was used as the terrain model to accurately represent ground surface morphology, flow paths, topographic depressions, and floodplain boundaries. Model performance was validated using observed water level and discharge data obtained from the BBWS Ciliwung Cisadane gauging stations, complemented by field evidence of flood inundation.

The simulation results show that under the Q25 scenario, Halim Reservoir reduced the downstream peak discharge from 102.97 to 85.66 m^3/s (16,8%) and decreased the inundated area from 31.98 to 24.94 *ha* (22,0%). In contrast, during the extreme flood event of 1 January 2020, reductions in peak discharge and inundated area were limited to 2,3% and 1,0%, respectively.

Based on the reductions in downstream peak discharge and inundated area used as the evaluation indicators in this study, Halim Reservoir demonstrated satisfactory performance under the Q25 design flood scenario; however, its contribution became considerably limited during the extreme flood event, when the flood volume exceeded the reservoir storage capacity. The findings demonstrate that the integration of HEC-RAS 2D with a LiDAR-derived DTM provides a detailed representation of flood dynamics and supports a more comprehensive evaluation of the hydraulic performance of flood-control infrastructure. This approach can serve as a reliable basis for flood mitigation planning and urban flood risk management in densely developed areas.

Keyword: Halim Reservoir, Sunter River, HEC-HMS, HEC-RAS 2D, LiDAR-derived Digital Terrain Model, flood mitigation