

Daerah Irigasi Rawa (DIR) Dadahup merupakan kawasan lahan rawa bertopografi datar dan berelevasi rendah yang rentan terhadap genangan akibat kejadian hujan, sehingga membutuhkan pengelolaan drainase berbasis sistem polder dengan pompa pembuangan yang andal. Meskipun sistem polder telah diterapkan, kinerja pompa eksisting dalam mengendalikan muka air internal masih belum optimal, khususnya pada bagian tengah dan hulu sistem. Penelitian ini bertujuan mengetahui kinerja operasional sistem polder dan pompa pembuangan serta mendapatkan skenario pengembangan yang paling efektif untuk mencapai target operasi muka air +0,8 hingga +1,0 m, sekaligus menilai kemampuan sistem dalam melindungi area dalam polder dari pengaruh hidrologi luar.

Metode penelitian meliputi analisis hidrologi hujan rancangan, analisis karakteristik aliran, dan pemodelan hidraulik tidak permanen menggunakan HEC-RAS. Pemodelan dilakukan pada beberapa skenario, yaitu kondisi eksisting, penambahan kapasitas pompa terpusat (Alternatif 1), dan penyebaran lokasi pompa ke tiga titik (Alternatif 2), termasuk penerapan pola operasi pompa berbasis ambang elevasi. Evaluasi kinerja dilakukan dengan meninjau respon dinamis muka air, durasi pemompaan dan pencapaian target operasi, serta kedalaman genangan secara spasial pada titik hulu, tengah, dan hilir sistem.

Hasil penelitian menunjukkan bahwa sistem polder secara umum telah mampu membatasi pengaruh langsung hidrologi luar, namun genangan internal masih didominasi oleh akumulasi hujan dan keterbatasan kapasitas pembuangan. Alternatif 2 memberikan kinerja terbaik dengan penurunan muka air yang lebih serempak, durasi pemompaan lebih efisien, serta pengurangan kedalaman genangan yang lebih merata. Alternatif 1 menunjukkan perbaikan terbatas dan berpotensi menimbulkan *over-drain* tanpa pengaturan operasi yang tepat, meskipun dapat dioptimalkan melalui pola operasi pompa. Penelitian ini menyimpulkan bahwa efektivitas pengendalian muka air pada sistem polder ditentukan tidak hanya oleh kapasitas pompa, tetapi juga oleh distribusi lokasi dan pola operasinya, serta merekomendasikan pengembangan sistem pompa terdistribusi dan kendali adaptif sebagai arah pengelolaan ke depan.

Kata kunci: sistem polder; pompa drainase; HEC-RAS; hujan rancangan; lahan rawa

ABSTRACT

The Dadahup Swamp Irrigation Area is a low-lying and relatively flat wetland system that is highly vulnerable to inundation during rainfall events, requiring a reliable polder-based drainage system supported by pumping stations. Although a polder system has been implemented, the performance of the existing pumps in controlling internal water levels remains inadequate, particularly in the middle and upstream sections of the system. This study aims to know the operational performance of the polder drainage system and pumping stations and to get the most effective development scenario for achieving the target operational water level of +0.8 to +1.0 m, while also assessing the ability of the polder system to protect the interior area from external hydrological influences.

The research methodology consists of design rainfall analysis, flow characteristic analysis, and unsteady hydraulic modeling using HEC-RAS. Several operational scenarios were simulated, including the existing pump configuration, centralized pump capacity expansion (Alternative 1), and spatially distributed pump placement at three locations (Alternative 2), with additional consideration of pump operation rules based on water level thresholds. System performance was evaluated by analyzing dynamic water-level responses, pumping duration and target attainment, and the spatial distribution of inundation depths at downstream, midstream, and upstream observation points.

The results indicate that the polder system is generally effective in limiting direct hydrological impacts from outside the polder; however, internal inundation is primarily governed by accumulated rainfall and insufficient drainage capacity. Alternative 2 demonstrates the best overall performance, characterized by more uniform water-level reduction, shorter and more efficient pumping duration, and a more evenly distributed reduction of inundation depth across the system. Alternative 1 provides limited improvement and may induce over-drainage if not accompanied by appropriate operational control, although its performance can be enhanced through adaptive pump operation. This study concludes that effective water-level control in polder systems depends not only on pump capacity but also on spatial configuration and operational strategy, and it recommends distributed pumping systems and adaptive control as key directions for future polder management.

Keywords: polder system; drainage pumps; HEC-RAS; design rainfall; wetlands