

Land Use Change Projection and Spatial Utilization Suitability for Water Ecosystem Services Performance in The Code and Gajahwong Watersheds

By:

Dwi Novrian Nugroho

23/526642/PMU/11617

ABSTRACT

The increasing number of settlements in the upstream part of the watershed reduces the performance of ecosystem services as a regulating and providing water. Floods caused by the overflow of the Code and Gajahwong Rivers have occurred. Additional space allocation for residential areas has the potential to increase land use change. It is necessary to project land use change and its impact on water ecosystem services.

This study aims to analyze the effects of land use changes in 2008, 2024, and the projected 2040 on water ecosystem services in the Code (3,643.7 ha) and Gajahwong catchment (4,325.5 ha), located in Sleman Regency, Yogyakarta, using consistent climate parameters. The 2040 land use projection model was developed using the Artificial Neural Network-Cellular Automata-Markov Chain (ANN-CA-MC) method. Water ecosystem services were analyzed using the Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) and InVEST Seasonal Water Yield (SWY) tools. HEC-HMS produced calibrated flow hydrographs, including peak discharge and daily average discharge, while SWY-InVEST generated raster data representing quickflow and baseflow values.

The study results indicate that land use changes over the study period predominantly involved the conversion of agricultural land and mixed gardens into residential areas. The increase in urban areas between 2008–2024 and 2024–2040 was 10.5% and 14.1% for the Code Watershed, while for the Gajahwong Watershed, it was 11.0% and 8.4%. The increasing settlement area in 2008-2024 led to increases in peak discharge, quickflow, and baseflow by 21,5%, 9,6%, and 3,3% for the Code Watershed, and 25,3%, 8,3%, and 4,2% for the Gajahwong Watershed. Meanwhile in 2024-2040, peak discharge, quickflow, and baseflow increased by 25,3%, 12,7%, and 3,5% for the Code Watershed, and 10,5%, 5,4%, and 3,4% for the Gajahwong Watershed. These changes reflect an increase in surface runoff rates and potentially an increase in flood risk. The findings of this study are expected to assist policymakers in formulating strategies that support sustainable development.

Keyword: *land-use change; water ecosystem services; HEC-HMS model; InVEST SWY model; ANN-CA-Markov*

Proyeksi Perubahan Penggunaan Lahan dan Kesesuaian Pemanfaatan Ruang Terhadap Kinerja Jasa Ekosistem Air di Das Code dan Gajahwong

Oleh:

Dwi Novrian Nugroho

23/526642/PMU/11617

INTISARI

Peningkatan lahan permukiman pada bagian hulu Daerah Aliran Sungai (DAS) menurunkan kinerja jasa ekosistem sebagai pengatur dan penghasil air. Terjadi banjir yang disebabkan luapan Sungai Code dan Gajahwong. Penambahan alokasi ruang kawasan permukiman berpotensi meningkatkan alih fungsi lahan. Perlu dilakukan proyeksi perubahan penggunaan lahan dan dampaknya terhadap jasa ekosistem air.

Penelitian ini bertujuan untuk menganalisis dampak perubahan penggunaan lahan tahun 2008, 2024, dan proyeksi 2040 terhadap jasa ekosistem air di DAS Code (3643,7 ha) dan Gajahwong (4325,5 ha), Kabupaten Sleman, Yogyakarta. Model proyeksi penggunaan lahan 2040 menggunakan metode *Artificial Neural Network-Cellular Automata-Markov Chain* (ANN-CA-MC). Perhitungan jasa ekosistem air menggunakan *Hydrologic Engineering Center-Hydrologic Modeling System* (HEC-HMS) menghasilkan simulasi hidrograf aliran yang terkalibrasi, sedangkan *Seasonal Water Yield* (SWY)-InVEST menghasilkan data raster berupa nilai *quickflow* dan *baseflow*. Seluruh model digerakkan dengan data iklim yang sama, yaitu Januari 2024 (HEC-HMS) dan 2023 (SWY InVEST) sehingga dampak perubahan hidrologi DAS hanya disebabkan oleh perubahan lahan.

Hasil analisis proyeksi perubahan penggunaan lahan yang dominan adalah alih fungsi lahan pertanian dan kebun campuran menjadi permukiman. Kenaikan permukiman selama 2008-2024 dan 2024-2040 masing-masing sebesar 10,5% dan 14,1% untuk DAS Code, sedangkan DAS Gajahwong sebesar 11,0% dan 8,4%. Peningkatan area permukiman tahun 2008-2024 berdampak pada kenaikan debit puncak, *quickflow*, dan *baseflow* masing-masing sebesar 21,5%, 9,6%, dan 3,3% untuk DAS Code, sedangkan DAS Gajahwong sebesar 25,3%, 8,3%, dan 4,2%. Sementara itu, pada 2024-2040 kenaikan debit puncak, *quickflow*, dan *baseflow* masing-masing sebesar 25,3%, 12,7%, dan 3,5% untuk Das Code, sedangkan untuk DAS Gajahwong sebesar 10,5%, 5,4%, dan 3,4%. Perubahan ini mencerminkan adanya peningkatan laju limpasan permukaan dan berpotensi meningkatkan risiko banjir. Hasil studi ini diharapkan dapat membantu pemerintah merumuskan kebijakan yang mendukung pembangunan berkelanjutan.

Kata Kunci: perubahan penggunaan lahan; jasa ekosistem air; model HEC-HMS; model SWY InVEST; ANN-CA-Markov