

GEOMORFOLOGI TANAH UNTUK PENGELOLAAN SUMBERDAYA LAHAN BENTANG PERALIHAN GUNUNGAPI TUA DAN GUNUNGAPI MUDA DI PULAU JAWA BAGIAN SELATAN

INTISARI

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Proses tektonik-vulkanik antar dua sistem vulkanik membentuk karakteristik sumber daya lahan yang spesifik. Interaksi sifat fisik lahan berikut isu sosial di zona Transisi Gunungapi Kuarter-Neogen (TGKN) memunculkan kompleksitas masalah tertentu. Penelitian ini bertujuan untuk menyusun model pengelolaan sumberdaya lahan bentang peralihan gunungapi muda (Kuarter) dan gunungapi tua (Neogen). Pembatasan zona TGKN dilakukan melalui pengelompokkan parameter permukaan diantaranya atribut sungai yaitu orde dan *channel sinuosity* dan atribut medan yakni *elevation*, *slope*, *aspect*, *roughness*, dan *curvature*. Teknik statistik spasial *multivariate clustering* digunakan untuk identifikasi pola dan kesamaan atribut, sehingga mempermudah klasifikasi lanskap menjadi zona-zona yang homogen. Bukti pelapukan batuan induk diperoleh dari uji fisika-kimia dan mineralogi tanah, yaitu SEM, XRD, dan SEM-EDX pada horizon C. Proses geomorfologi permukaan yang berinteraksi dengan usaha budidaya diidentifikasi secara mendetil menggunakan data LiDAR dan foto udara.

Zona TGKN terletak diantara dua sistem vulkanik berbeda yang dicirikan oleh: atribut sungai, atribut medan, dan karakteristik material penyusunnya. Zona TGKN Sumbing-Menoreh terletak pada ketinggian 400-800 mdpl, pola aliran radial sentrifugal, kelerengan sedang-agak curam, serta morfologi perbukitan rendah. Rentang nilai kelengkungan permukaan lahan zona TGKN adalah -0.945 hingga 2.803, yang mengindikasikan adanya kombinasi lereng konkaf dan konveks. Orientasi lereng ke timur, selatan, dan tenggara. Indeks kekasaran permukaan lahan berkisar antara 0,765 hingga 0,995 yang menunjukkan heterogenitas morfologi mikro permukaan lahan.

Kompleksitas material penyusun zona TGKN dibentuk oleh pelapukan endapan material material vulkanik kuarter, material alterasi batuan vulkanik neogen, dan kombinasi keduanya akibat proses-proses pengikisan dan pengendapan yang terjadi barusan. Mineral dominan yang ditemukan pada bahan induk tanah adalah kelompok klei tipe 1:1 berupa mineral kaolinitik dan haloistik. Alterasi hidrotermal membentuk endapan material tanah sangat tebal, tekstur dominan klei, tipe struktur tiang-berukuran mega, BV dan BJ rendah, porositas kurang baik, permeabilitas lambat, pH rendah, dan BO rendah. Karakteristik mineralogi dan fisika-kimia material tanah yang menyelimuti morfologi permukaan lahan miring dengan curah hujan tinggi menjadi penyebab tingginya potensi ancaman bencana erosi, longsor, dan kekeringan yang perlu dikelola secara spesifik. Diperlukan pengelolaan dan pengembangan sumberdaya lahan sesuai karakteristik dengan memaksimalkan potensi dan mengurangi faktor pembatasnya. Pengelolaan zona TGKN harus dilakukan secara terpadu melalui pendekatan konservasi lahan berbasis vegetasi, teknik pengendalian air, penguatan sosial-ekonomi masyarakat, serta analisis spasial menyeluruh terhadap parameter permukaan dan bawah permukaan untuk merumuskan strategi pengembangan lahan yang adaptif, produktif, dan tangguh terhadap bencana.

Kata Kunci: geomorfologi tanah, zona transisi Gunungapi Kuarter-Neogen, pengelolaan sumberdaya lahan

SOIL GEOMORPHOLOGY FOR LAND RESOURCE MANAGEMENT IN THE TRANSITIONAL LANDSCAPE BETWEEN OLD AND YOUNG VOLCANOES IN THE SOUTHERN PART OF JAVA ISLAND

ABSTRACT

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Tectonic–volcanic interactions between two distinct volcanic systems shape the specific characteristics of land resources in the region. The interplay between physical land properties and socio-environmental factors within the Quaternary–Neogene Volcanic Transition (QNVT) zone presents a range of complex challenges. This study aims to develop a land resource management model tailored to the transitional landscape between younger (Quaternary) and older (Neogene) volcanic formations. The delineation of the QNVT zone is based on the classification of surface parameters, including fluvial attributes such as stream order and channel sinuosity, as well as terrain features such as elevation, slope, aspect, roughness, and curvature. Multivariate clustering techniques in spatial statistics are employed to identify patterns and similarities among these attributes, allowing for the classification of the landscape into homogeneous zones. Indicators of source rock weathering are derived from physicochemical and mineralogical analyses of soil samples, specifically through SEM, XRD, and SEM-EDX testing on the C horizon. Detailed identification of surface geomorphological processes and their interaction with agricultural practices is conducted using LiDAR data and aerial imagery.

The QNVT zone is situated between two distinct volcanic systems and is characterized by variations in river attributes, terrain features, and the properties of the underlying materials. The Sumbing–Menoreh section of the QNVT zone lies at an elevation of 400–800 meters above sea level, exhibiting a centrifugal radial drainage pattern, moderate to steep slopes, and low hill morphologies. Curvature values across the land surface in this zone range from -0.945 to 2.803, reflecting a combination of concave and convex slope forms. Slope aspects predominantly face east, south, and southeast. The land surface roughness index ranges from 0.765 to 0.995, indicating considerable heterogeneity in micromorphological surface features.

The complexity of the materials comprising the QNVT zone results from the weathering of Quaternary volcanic deposits, altered Neogene volcanic rocks, and their combination through recent erosion and deposition processes. The dominant minerals in the parent soil material belong to the 1:1 clay mineral group, primarily kaolinitic and halloysitic in composition. Hydrothermal alteration has produced thick soil deposits characterized by a clay-dominated texture, mega-sized columnar structures, low bulk volume and bulk density, poor porosity, slow permeability, low pH, and low organic matter content. These mineralogical and physicochemical characteristics, combined with sloping landforms and high rainfall, contribute to an elevated risk of erosion, landslides, and drought conditions that require site-specific management interventions. Sustainable land resource management in the QNVT zone must be tailored to these characteristics by maximizing potential while mitigating limiting factors. An integrated management approach is essential, encompassing vegetation-based land conservation, water control techniques, socio-economic empowerment of local

communities, and comprehensive spatial analysis of both surface and subsurface parameters. Such an approach is critical to developing adaptive, productive, and disaster-resilient land use strategies.

Keywords: soil geomorphology, Quaternary-Neogene volcanic transition zone, land resource management