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Harnessing Spatial and Multi-Criteria Decision Analysis (MCDA) to Optimize Land Suitability for Kenaf Cultivation in Kelantan: Pathways for Sustainable Economic Development

Nur Afiqah Ariffin^{1,2}  | Zainol Jamil^{1,3} | Yaniza Shaira Zakaria^{1,4}  | Nur Ain Che Mat Ali¹ | Azizul Ahmad⁵ 

¹Agricultural and Environmental Statistics Division (BPPAS), Department of Statistics Malaysia (DOSM), Putrajaya, Malaysia | ²HS Innovators Sdn Bhd, Shah Alam, Selangor, Malaysia | ³Department of Statistics Malaysia (DOSM) Pulau Pinang, George Town, Pulau Pinang, Malaysia | ⁴Institute of Oceanography and Environment (INOS), Universiti Malaysia Terengganu, Kuala Nerus, Terengganu, Malaysia | ⁵Centre for Spatially Integrated Digital Humanities (CSIDH), Faculty of Social Sciences & Humanities, Universiti Malaysia Sarawak, Sarawak, Malaysia

Correspondence: Yaniza Shaira Zakaria (yanizashaira86@gmail.com) | Azizul Ahmad (aazizul@unimas.my)

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ABSTRACT

In Kelantan, entrenched land degradation and extensive idling of agricultural lands exacerbate rural poverty. Current top-down planning often overlooks local geographic and social constraints, despite state initiatives to convert idle lands and strengthen rural livelihoods. To address this, an integrated GIS–MCDA framework (using AHP) was developed to identify ecologically and socioeconomically optimal land for kenaf cultivation. Eight weighted criteria (land use, soil fertility and series, slope, elevation, geology, and proximity to rivers and roads) were combined via AHP in GIS, a well-established land-suitability method. The resulting suitability map was validated against the 2024 Agricultural Census and overlaid with e-Kasih poverty data. The analysis identifies highly suitable kenaf zones in Kelantan's inland districts (overlapping areas of acute poverty), a distribution notably misaligned with official coastal development zones. Overlaying suitability with vulnerability data highlights gaps in current zoning and reveals opportunities for targeted agricultural diversification. By integrating land potential with socioeconomic vulnerability, the framework informs evidence-based land rehabilitation and rural development strategies. Ultimately, this GIS–MCDA approach supports sustainable, inclusive land use planning and offers evidence-based guidance for Malaysia to rehabilitate degraded lands and boost rural incomes. These outcomes contribute directly to SDG 1 (no poverty) and SDG 15 (life on land), and provide a replicable model for sustainable agricultural planning under global development agendas.

1 | Introduction

The kenaf plant (*Hibiscus cannabinus* L.) has gained recognition worldwide as a fast-growing, versatile fiber crop with a remarkable ability to thrive in tropical and subtropical climates (Austin et al. 2024; Odumuyiwa et al. 2024). Traditionally grown for its fibrous stalks in paper and textile applications, kenaf's uses have expanded in recent years to include pulp and paper products,

bio-composite materials, animal feed, pharmaceuticals, and bio-energy all with relatively low input requirements (WHO 2023). For example, shifting Malaysian tobacco farmers into kenaf cultivation has yielded “good returns on investment” with minimal additional labor or cost (WHO 2023). Economic analyses confirm that kenaf can generate positive net returns under favorable conditions, suggesting it can outperform many conventional crops and serve as a catalyst for rural income generation. These

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