

Distribution of oil palm plantations and their suitability with spatial planning: An assessment in Aceh, Indonesia

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Abstract. Oil palm plantations are undoubtedly recognized as a significant contributor to economic development in Indonesia. However, uncontrolled expansion of oil palm cultivation presents challenges due to its potential negative consequences on the environment and society. This study aims to assess the distribution of oil palm plantations and their suitability with spatial planning in the Aceh Province, Indonesia. We obtained spatial data on plantations from official authorities, which underwent an extensive inventory process during the year 2021. The total area of oil palm plantations in Aceh was reported at 706,943.87 ha, primarily concentrated in the eastern and western lowland areas of Aceh mainland. Through spatial analysis, we identified that approximately 40% of the oil palm plantations are located in areas where plantation development should not be permitted according to existing spatial planning regulations. This study provides important information for land use management in Aceh and offers policy recommendations to promote sustainable oil palm cultivation practices.

1 Introduction

Oil palm industry holds significant importance for Indonesia's economy, considering its contribution to regional income generation and job opportunities. Oil palm is favored over other plantation commodities due to its advantages in terms of cultivation system efficiency, productivity, return on investment, and versatility [1]. Globally, Indonesia plays a major role as the leading producer of crude oil palm (CPO), which is further processed into various food, cosmetic, hygiene, and bioenergy products. The Ministry of Agriculture of the Republic of Indonesia reported that the volume of CPO exports reached 7,170,956 tons in 2020, valued at 4.7 billion USD [2]. Additionally, rural communities greatly benefit from the existence of oil palm plantations, providing livelihoods, accelerating development, and offering various socioeconomic advantages.

Despite its positive influences, oil palm production is frequently criticized for its detrimental effects on the environment and society. For instance, the expansion of oil palm plantations is deemed responsible for the loss of forest cover in recent decades [3]. Improper agricultural practices contribute to increased risks of forest fires and the destruction of critical lands, particularly tropical peat swamp ecosystems [4]. These issues become more complex when combined with escalating tenure conflicts among various actors,

including local communities, private companies, and state [5].

Sustainable oil palm certification is regarded as a key solution to ensure the governance of plantations that adhere to environmental, social, and economic sustainability principles. At the global level, the concept of sustainable oil palm is promoted by the Roundtable on Sustainable Oil palm (RSPO). In Indonesia, this certification scheme is known as the Indonesian Sustainable Oil palm (ISPO), mandated by the government for both plantation companies and smallholder farmers. However, research indicates that the implementation of ISPO certification still faces structural and sociocultural challenges, leading to suboptimal control over sustainability standards [1].

In Indonesia, the largest oil palm production centers are found in Sumatra and Kalimantan Islands. Aceh is one of the provinces in Sumatra where oil palm dominates the plantation commodities, thanks to its ideal geographical settings. As shown in Figure 1, the availability of lowland areas and its proximity to the equator (which has implications for climate) are crucial indications of the suitability of oil palm production. Statistics Indonesia noted oil palm as the commodity with the largest plantation area in Aceh [6]. Its average productivity is 2745 kg/ha per year in the form of CPO. The production has shown an increasing trend in the past five years.

The aim of this study is to describe the spatial distribution of oil palm plantations throughout the Aceh

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