

ABSTRAK

KAJIAN RISIKO LINGKUNGAN AKIBAT AKTIVITAS PEMBUKAAN LAHAN PERTAMBANGAN NIKEL TERHADAP EKOSISTEM TANAMAN LOKAL MERICA RAMBAT MENGGUNAKAN METODE *FAILURE MODE AND EFFECTS* *ANALYSIS* (FMEA)

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Indonesia memiliki potensi cadangan nikel, salah satunya di Provinsi Sulawesi Selatan. Rencana ekspansi pertambangan oleh PT. X Tbk di Blok X yang mencakup area konsesi seluas 17.776,78 Ha di wilayah Loeha Raya, Kabupaten Luwu Timur, berpotensi menimbulkan dampak lingkungan. Wilayah ini merupakan sentra pertanian merica (*Piper nigrum L.*) yang menjadi tumpuan ekonomi masyarakat di lima desa (Bantilang, Rante Angin, Tokalimbo, Masiku, dan Loeha). Penelitian ini bertujuan untuk mengidentifikasi potensi risiko lingkungan, menganalisis faktor penyebab kerusakan utama, serta merumuskan strategi mitigasi dampak pertambangan terhadap keberlanjutan ekosistem tanaman merica menggunakan metode *Failure Mode and Effects Analysis* (FMEA).

Penelitian dilakukan melalui pendekatan kuantitatif dan kualitatif. Pengumpulan data mencakup observasi lapangan, pengambilan dan pengujian laboratorium sampel (tanah, air, dan udara) untuk mengetahui rona awal lingkungan, serta diskusi mendalam dengan petani lokal. Data tersebut diintegrasikan ke dalam analisis FMEA sebagai *baseline* untuk menentukan nilai *Risk Priority Number* (RPN) guna memetakan tingkat prioritas risiko.

Hasil penelitian menunjukkan bahwa kondisi rona awal tanah didominasi karakteristik ultramafik yang masam, namun kualitas air dan udara masih tergolong baik dan mendukung budidaya merica. Berdasarkan analisis FMEA, aktivitas penimbunan bijih nikel (*stockpile*) teridentifikasi sebagai sumber risiko tertinggi dengan nilai RPN mencapai 100. Risiko ini memicu terbentuknya air lindi yang menyebabkan pengasaman tanah dan kontaminasi logam berat (Fe dan Mn) pada air irigasi yang bersifat fitotoksik. Risiko signifikan lainnya meliputi kekeringan lahan akibat *dewatering* (RPN 60) dan gangguan fotosintesis akibat debu *hauling* (RPN 50). Oleh karena itu, strategi mitigasi diprioritaskan pada rekayasa teknis (*engineering control*), meliputi pembuatan saluran drainase dan kolam pengendap (*sediment pond*) yang dilengkapi sistem *lime treatment* untuk menetralkan pH, pembuatan kolam imbuhan, serta penerapan sabuk hijau (*green belt*) guna menjamin keberlanjutan ekosistem merica.

Kata kunci: Pertambangan Nikel, *Piper nigrum L.*, FMEA, Risiko Lingkungan, Mitigasi.

ABSTRACT

ENVIRONMENTAL RISK ASSESSMENT OF THE IMPACT OF NICKEL MINING LAND CLEARING ACTIVITIES ON THE LOCAL PEPPER VINE ECOSYSTEM USING THE FAILURE MODE AND EFFECTS ANALYSIS (FMEA) METHOD

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*Indonesia has potential nickel reserves, one of which is in South Sulawesi Province. PT. X Tbk's mining expansion plan in Block X, which covers a concession area of 17,776.78 hectares in the Loeha Raya region, East Luwu Regency, has the potential to cause environmental impacts. This area is a center for pepper (*Piper nigrum* L.) farming, which is the economic mainstay of the communities in five villages (Bantilang, Rante Angin, Tokalimbo, Masiku, and Loeha). This study aims to identify potential environmental risks, analyze the main causes of damage, and formulate mitigation strategies for the impact of mining on the sustainability of the pepper plant ecosystem using the Failure Mode and Effects Analysis (FMEA) method.*

The research was conducted using quantitative and qualitative approaches. Data collection included field observations, laboratory sampling and testing (soil, water, and air) to determine the initial state of the environment, as well as in-depth discussions with local farmers. The data was integrated into FMEA analysis as a baseline for determining the Risk Priority Number (RPN) value to map the level of risk priority.

The results of the study show that the initial soil conditions are dominated by acidic ultramafic characteristics, but the quality of water and air is still relatively good and supports pepper cultivation. Based on FMEA analysis, nickel ore stockpiling activities were identified as the highest risk source with an RPN value of 100. This risk triggers the formation of leachate, which causes soil acidification and heavy metal (Fe and Mn) contamination in phytotoxic irrigation water. Other significant risks include land drought due to dewatering (RPN 60) and photosynthesis disruption due to hauling dust (RPN 50). Therefore, mitigation strategies are prioritized in engineering controls, including the construction of drainage channels and sediment ponds equipped with lime treatment systems to neutralize pH, the construction of recharge ponds, and the implementation of green belts to ensure the sustainability of the pepper ecosystem.

Keywords: Nickel Mining, *Piper nigrum* L., FMEA, Environmental Risk, Mitigation.