

ABSTRAK

EVALUASI DATA PERANGKAT EDDY COVARIANCE STATION (ECS) DAN DATA LI-COR (LI-7500) MENGGUNAKAN METODE ANALISIS DESKRIPTIF

Studi Kasus Pengukuran Emisi Karbon di Perkebunan Kelapa Sawit Lahan Gambut

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Perkebunan kelapa sawit di lahan gambut merupakan sumber penting emisi gas rumah kaca, khususnya karbon dioksida (CO_2) dan metana (CH_4), akibat oksidasi dan dekomposisi cadangan karbon pada biomassa serta material organik gambut ketika aerasi meningkat. Besarnya stok karbon, sensitivitas terhadap perubahan hidrologi dan tata air, serta pengaruh faktor meteorologis menjadikan ekosistem ini prioritas pemantauan berbasis fluks. Dalam kerangka monitoring–reporting–verification (MRV) kredibel, diperlukan pengukuran kontinu yang lebih representatif berfrekuensi tinggi pada skala ekosistem untuk menangkap dinamika harian–musiman, menapis gangguan sesaat, dan memisahkan sinyal proses (misalnya respirasi ekosistem) dari artefak instrumentasi. Metode eddy covariance (EC) dengan instrumen seperti Eddy Covariance Station (ECS) dan analisator gas terbuka LI-7500 menyediakan kerangka tersebut seraya merekam parameter mikroklimat (temperatur udara, kelembapan relatif/RH, uap air, dan tekanan udara) untuk interpretasi proses. Penelitian ini mengevaluasi fungsionalitas, durabilitas, dan reliabilitas sebuah ECS yang dioperasikan pada perkebunan kelapa sawit lahan gambut PT. Persada Dinamika Lestari, serta membandingkan kualitas dan kelengkapan data antara ECS Station 2 dan LI-7500. Analisis dilakukan secara deskriptif dengan visualisasi deret waktu dan ringkasan statistik (minimum, maksimum, rerata, simpangan baku, dan varians) guna menilai konsistensi antarperangkat. Dataset yang dianalisis mencakup $\pm 1,85$ juta catatan temporal per perangkat selama tujuh hari pada awal setiap bulan periode Juni–Desember 2024; frekuensi akuisisi 7 Hz (ECS) dan 10 Hz (LI-7500). Data kemudian diagregasi menjadi resolusi 1 menit dan 30 menit untuk menilai keterwakilan sinyal, dan dilakukan penapisan kualitas untuk menghapus *outlier*, *spike*, dan jeda. Hasil menunjukkan bahwa, berdasarkan simpangan baku, nilai minimum pada LI-7500 lebih kecil (selisih relatif $\approx 0,21\%$), mengindikasikan stabilitas pengukuran yang lebih baik pada kondisi tenang; sebaliknya, nilai maksimum simpangan baku pada ECS lebih kecil ($\approx 0,44\%$), menandakan performa kompetitif saat variabilitas tinggi. Setelah penapisan dan agregasi, kurva tren serta distribusi konsentrasi/flux CO_2 dari ECS selaras dengan LI-7500, memvalidasi kemampuannya merepresentasikan dinamika lapangan. Meskipun demikian, kelengkapan data LI-7500 lebih baik

(lebih sedikit *missing data*) dibandingkan ECS, mengisyaratkan perlunya peningkatan pada keberlanjutan daya, penjadwalan pemeliharaan, dan ketahanan sistem akuisisi. Secara keseluruhan, ECS yang dikembangkan oleh Tim Peneliti Universitas Lampung layak digunakan untuk pemantauan fluks karbon di lahan gambut, dengan prioritas perbaikan kontinuitas data guna memenuhi kebutuhan MRV dan mendukung kebijakan mitigasi emisi di perkebunan kelapa sawit.

Kata Kunci: Karbon, Lahan Gambut, *Eddy Covariance Station* (ECS), LI-7500, Analisis Deskriptif.

ABSTRACT

EVALUATION OF EDDY COVARIANCE STATION (ECS) DEVICE DATA AND LI-COR DATA (LI-7500) USING DESCRIPTIVE ANALYSIS METHOD

Case Study of Carbon Emission Measurement in Peatland Oil Palm Plantations

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Oil palm plantations on tropical peatlands are significant sources of greenhouse gases, particularly carbon dioxide (CO₂) and methane (CH₄), as increased aeration promotes oxidation and decomposition of carbon stocks in plant biomass and peat organic matter. The combination of large carbon reservoirs, sensitivity to hydrological and water-management changes, and strong meteorological forcing makes these ecosystems a high priority for flux-based monitoring. For credible monitoring–reporting–verification (MRV), continuous, high-frequency measurements at the ecosystem scale are required to capture diurnal-to-seasonal dynamics, filter transient disturbances, and separate process signals (e.g., ecosystem respiration) from instrumentation artifacts. The eddy-covariance (EC) method, implemented with an Eddy Covariance Station (ECS) and an open-path gas analyzer such as the LI-7500, provides this framework while also recording key microclimate variables (air temperature, relative humidity, water vapor, and air pressure) for process interpretation. This study evaluates the functionality, durability, and reliability of an ECS deployed in a peatland oil palm plantation operated by PT. Persada Dinamika Lestari and compares data quality and completeness between ECS Station 2 and an LI-7500. We conduct descriptive analyses with time-series visualization and statistical summaries (minimum, maximum, mean, standard deviation, and variance) to assess inter-instrument consistency. The dataset comprises approximately 1.85 million temporal records per instrument over seven days at the beginning of each month from June through December 2024, sampled at 7 Hz (ECS) and 10 Hz (LI-7500). Records are then downsampled to 1-minute and 30-minute resolutions—standard EC averaging periods—to evaluate signal representativeness. Quality control includes removal of outliers, spikes, and gaps to ensure robust comparison. Results indicate that, based on standard deviation, the LI-7500 exhibits a smaller minimum value (relative difference $\approx 0.21\%$), suggesting slightly greater stability under quiescent conditions. Conversely, the ECS shows a smaller maximum standard deviation ($\approx 0.44\%$), indicating competitive performance during periods of higher variability. After filtering and aggregation, trend curves and distributions of CO₂ concentration/flux

derived from the ECS closely align with those from the LI-7500, validating the ECS's ability to capture field dynamics. Nevertheless, the LI-7500 achieves better data completeness (fewer missing records), highlighting the need to enhance ECS power autonomy, maintenance scheduling, and acquisition-system resilience. Overall, the ECS developed by the University of Lampung research team is suitable for carbon-flux monitoring on peatland oil palm plantations, provided improvements to data continuity are prioritized to meet MRV requirements and to inform emission-mitigation decisions in plantation management.

Keywords: Carbon, Peatland, Eddy Covariance Station (ECS), LI-7500, Descriptive Analysis.