From Carbon Accounting to Spatial Carbon Management

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ABSTRACT

Effective carbon-neutrality planning requires more than quantifying total greenhouse gas (GHG) emissions. It also requires understanding the spatial relationships among emission sources, carbon sinks, and existing mitigation measures. However, conventional carbon accounting mainly reports aggregate or building-level emissions, making it difficult to identify place-specific management priorities. This study developed a spatial carbon management approach for Changwon National University, South Korea. Scope 1 and Scope 2 GHG emissions were calculated from building energy use and vehicle activity data. Carbon sequestration was estimated from UAV-derived tree canopy data, and emissions and sequestration were integrated into 10 m × 10 m grid cells to assess spatial carbon balance. Avoided emissions from existing photovoltaic (PV) systems were estimated separately based on installed capacity using a capacity-based reduction factor. Total GHG emissions were 16,486.7 tCO_2-eq/yr, while tree canopy sequestration was 146.6 tCO_2/yr, equivalent to 0.89% of total emissions. Grid analysis revealed contrasting carbon-balance patterns among high-emission buildings. One high-emission area had limited surrounding tree canopy, whereas the highest-emitting building was located next to a large sequestration-dominant cluster. These differences were not evident from building-level emission rankings alone. Separately, existing PV systems avoided an estimated 542.8 tCO_2-eq/yr and were concentrated mainly in relatively high-emission buildings. The results show that campus carbon management should move beyond emission accounting toward spatial diagnosis that considers emission sources, carbon sinks, and mitigation measures together. This approach provides a practical basis for identifying place-specific priorities and selecting targeted carbon management strategies.

Keywords: Spatial carbon balance/ Carbon management/ UAV remote sensing/ Geographic information system (GIS)

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