31. Temporal Reliability and Spatial Error Patterns of the GLC-FCS30D Land Cover Product: A Multi-Temporal Assessment in Bari, Southern Italy

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Reliable land-cover information is essential for environmental monitoring and spatial planning, yet the thematic performance of annual global landcover products may vary across classes, locations, and observation years. This study evaluates the multi-temporal thematic accuracy and spatial structure of classification errors in the GLC-FCS30D product across the Metropolitan City of Bari, Southern Italy, for nine reference years between 2000 and 2022. The original legend was harmonized into six land-cover classes, while reference samples were generated through visual interpretation and manual digitization of Landsat imagery. Classification performance was assessed using confusion-matrix metrics, including Overall Accuracy, Producer's Accuracy, User's Accuracy, and Cohen's Kappa. The spatial organization of classification errors was investigated through multi-scale Global Moran's I and class-specific Local Getis–Ord Gi∗statistics. OverallAccuracy remained relatively stable, ranging from 79.49% to 81.34%, with Kappa values between 0.71 and 0.75. However, this aggregate stability concealed substantial differences among land-cover classes. Cropland, woody vegetation, built-up areas, and water generally showed comparatively high accuracy, whereas grassland and bare land exhibited persistent omission errors and greater temporal variability. At the selected 1000 m aggregation scale, classification errors exhibited positive spatial autocorrelation in all assessment years, with the magnitude varying substantially through time. Moran's I increased from 0.061 in 2000 to 0.109 in 2003, 0.142 in 2006, and 0.210 in 2013, reaching a maximum of 0.274 in 2020 before declining to 0.211 in 2022. Multi-scale comparison further demonstrated sensitivity of Moran's I to the spatial aggregation scale, although the direction and magnitude of this effect varied among assessment years. Local hotspot analysis revealed geographically restricted and class-dependent concentrations of errors, with statistically significant hotspots detected only in selected assessment years and particularly localized patterns for different land-cover classes. These findings demonstrate that temporally stable aggregate accuracy does not necessarily imply uniform reliability across land-cover classes or geographic areas. The integration of conventional accuracy metrics with global and local spatial statistics therefore provides a more complete assessment of the suitability and limitations of annual global land-cover products for regional applications.