

Satellite Remote Sensing for Forest and Environmental Monitoring

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Satellite Remote Sensing for Forest and Environmental Monitoring

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Description

Satellite Remote Sensing for Forest and Environmental Monitoring provides a thorough examination of the applications and methods of satellite remote sensing for analyzing and managing forest environments. From forest height mapping to biodiversity modeling, the book explores a variety of Earth observation applications across cutting-edge sensors and platforms. The book addresses the ability of satellite technologies to observe and analyse ecological functions, conditions, and socioeconomic benefits for sustainable nature protection in the face of anthropogenic change, offering practical tools and strategies for large-scale forest inventories, fire risk assessment, and freshwater management. *Satellite Remote Sensing for Forest and Environmental Monitoring* offers postgraduates, researchers, and academics in remote sensing and geospatial technologies, particularly those focusing on forestry applications and related disciplines insights into environmental changes, land use patterns, vegetation mapping, and climate indicators.

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Abstract

Avian communities are highly sensitive to variations in vegetation structure, which in turn is strongly influenced by fine-scale habitat heterogeneity. Traditional categorical land-cover maps often fail to capture this heterogeneity, limiting our ability to monitor avian biodiversity across broad extents. To address this, we present a remote-sensing framework that integrates spaceborne light detection and ranging (LiDAR) metrics from the Global Ecosystem Dynamics Investigation (GEDI) with Sentinel-1 radar and Sentinel-2 multispectral data to generate vertical and horizontal vegetation structure encompassing biodiversity-rich environments. Our study covers three areas with contrasting Mediterranean habitats in southern Portugal—woodland, open woodland, and grasslands—where breeding birds were surveyed between 2020 and 2024. We used random forests models to evaluate the ability of GEDI-derived standard metrics (RH75, RH95, PAI, FHD, AGBD) and structural heterogeneity metrics (Shannon entropy, Rao's Q), to predict avian species richness and abundance along the woodland-grassland habitat gradient. We then developed a targeted model for an intermediate open woodland

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the lower overall densities, supported key specialists such as the little bustard (*Tetrax tetrax*), underscoring their essential role alongside structurally rich wood pastures. Although the random forests model for the tawny owl accounted for a smaller share of variance, it revealed a significant positive response to canopy height and a bimodal relationship with foliage height diversity (FHD). Together, these findings emphasize that Mediterranean bird communities depend upon a mosaic of habitat structures, such as layered woodlands with canopy gaps and understory clusters providing nesting, roosting, and foraging niches, while open terrains sustain species adapted to sparse cover. By integrating spaceborne LiDAR from GEDI with Sentinel-1 radar and Sentinel-2 optical data, our framework offers a scalable, fine-grained approach for biodiversity monitoring across Mediterranean landscapes that are overlooked for such applications. We recommend that conservation strategies maintain both three-dimensional woodland complexity and retain extensive grassland habitats to support flagship species. Future work linking GEDI metrics with detailed ground-based microhabitat surveys and avifaunal monitoring will be crucial for pinpointing the structural drivers of species distributions and refining management practices to maximize both richness and abundance.

Key concepts

- GEDI LiDAR data was applied to understand bird distributions in Mediterranean habitats.
- Upper canopy heterogeneity and density strongly predicts bird diversity and abundance.
- Structurally simpler grasslands still hold high conservation value with specialists.
- Scalable GEDI-derived data supports biodiversity monitoring and policy frameworks.

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