

Satellite-Based Environmental Impact Assessment of Forest Habitats Affected by Volcanic and Wildfire Disturbances

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Abstract:

Forest ecosystems on volcanic islands are exposed to multiple disturbances that can rapidly alter canopy condition. This study investigates forest health dynamics on La Palma (Canary Islands, Spain) following two major events: the 2021 Tajogaite volcanic eruption and the 2023 wildfire. A multi-sensor remote sensing framework was developed by combining Sentinel-2 time series (2019–2024) with very-high-resolution WorldView imagery (2019, 2022, and 2024) to characterize both temporal trajectories and fine-scale spatial heterogeneity of forest response. More than 20 vegetation indices were evaluated, and the most informative were integrated into two composite forest health indicators: one for Sentinel-2, combining WDRVI, RENDVI, and NBR, and another for WorldView, combining WDRVI, RENDVI, and ARI2. The Sentinel-2 time series revealed contrasting disturbance signatures: areas influenced by the volcanic eruption showed an abrupt but relatively short-lived decline in vegetation vigor followed by recovery and localized greening, whereas wildfire-affected pine forests exhibited a marked drop in vigor with only partial recovery through 2024. WorldView data provided detailed maps of within-stand heterogeneity, highlighting patchy stress and recovery patterns near lava-ash deposits and within the burned perimeter. The results demonstrate the value of integrating medium-resolution dense time series with very high-resolution imagery for monitoring post-disturbance forest dynamics in complex island environments.

Keywords:

Forest health, vegetation indices, Sentinel-2, WorldView, volcanic eruption, wildfire.