Spatio-temporal pattern analysis for disturbance detection using satellite image time series

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Disturbance is characterized as a discrete event occurring within a short time period, leading to the disruption or alternation of the structure of an ecosystem, community, or population. Climate change, coupled with extreme disturbances like wildfires, tropical cyclones, and floods, poses severe threats to natural ecosystems. The changing frequency and intensity of these disturbances, influenced by climate change, can disrupt ecological processes, particularly nutrient cycling and ecosystem dynamics. As a result, there are significant shifts in species composition and changes in ecosystem function. It is essential to effectively capture and represent these complex disturbances. Traditional methods of comparing two images for disturbance detection have limitations when dealing with multiple-disturbance events. However, the utilization of time-series algorithms can provide more comprehensive and accurate detection, enabling a better understanding of disturbance patterns over time. In this study, a time-series algorithm incorporating moving average and linear-fit approaches was employed to detect disturbances using Moderate Resolution Imaging Spectroradiometer (MODIS) monthly Enhanced Vegetation Index (EVI) data from 2001 to 2022 in a subtropical montane cloud forest. Our findings revealed an average of 3.64 perturbations occurring during the study period. The area with the largest perturbations occurred during the years 2002, 2010, 2011, 2014, and 2017. The largest perturbed areas were observed in July 2011, followed by October 2017, May 2002, July 2006, and December 2013. These periods represent the times when the studied area experienced the most extensive disturbances, which included droughts, typhoons, and extreme low temperatures. Overall, this study emphasized that time-series algorithms and temporal segmentation of remotely sensed data sets offer a viable approach for perturbation detection and are applicable to the dynamics of disturbances and their impacts on ecosystems.

Keywords: EVI, time series analysis, change detection, MODIS, montane cloud forest